DETAILED PROPOSAL ON

PRELIMINARY EXPLORATION (G3 STAGE) FOR POTASH AND ASSOCIATED MINERALS IN PITUPURA BLOCK, DISTRICTS SAWAI MADHOPUR AND KARAULI RAJASTHAN

COMMODITY: POTASH AND ASSOCIATED MINERALS AREA: 9.70 SQ.KM

To
NATIONAL MINERAL EXPLORATION TRUST (NMET)

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INDEX (AS PER NMET FORMAT)

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SUMMARY OF THE BLOCK FOR PRELIMINARY EXPLORATION (G3 STAGE)

General Information About the Block

Sl No	Features	Details	
I	Block ID	GEO/NMET/RAJ/04/2023	
II	Exploration Agency	GeoExpOre Private Limited	
III	Previous Exploration Agency	G4 Stage by GSI	
IV	G4 stage Geological Report (Previous stage Geological Report)	Preliminary search of Potash in Glauconitic Sandstone/Shale of Vindhyan supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan. - Enclosed as Annexure-1	
V	Commodity	Potash and Associated Minerals	
VI	Mineral Belt	Glauconitic Sandstone/Shale of Vindhyan supergroup	
VII	Completion Period with entire schedule to complete the project	Pitupura Block 18 Months	
VIII	Objectives	 Carry out geological and structural mapping on a 1:10,000 scale to demarcate potash and associated mineral-bearing formations with structural features and identify the surface manifestations and lateral disposition of the mineralised zones. To drill 16 boreholes up to 12800m total depth (each 800 m) to prove the strike and depth persistence of ore-bearing formation mapped in the area, which in turn will aid in deciding the future course of the exploration program To estimate preliminary potash resources along with any accessory elements (if any) as per UNFC norms and minerals (evidence of mineral contents) rules – 2015 at the G-3 level. 	
IX	Whether the work will be carried out by the proposed agency or through outsourcing and details thereof.	Proposed Agency and Outsourcing agencies, which are empanelled by NMET through GeoExpOre Pvt Ltd Drilling: GEO TECH EXPLORATION 51, Panchdeep Nagar, Wardha Road, Nagpur - 440024 or any other competent agencies Lab Tests:	



	Components to be outsourced and name of the outsource agency	PSY PSN MY# Analytical & Quality Services Pvt Ltd., Vizag. or any other competent agency, Govt labs will be used whenever required (HGML, IBM, NGRI, IIMT (CSIR) & GSI) or NMET empanneld SHIVA ANALYTICALS (INDIA) PRIVATE LIMITED, Hoskote, Bangalore.		
X	Name / Number of Geoscientists	Sr. Geologists 2 Jr Geologists 2 Geophysicist 1		
XI	Expected Field days (Geology, Geophysics, Surveyor)	Geologists: 60 (HQ) + 150 days (Field) Geophysicist: 30 days Surveyor: 30 days		
1	Location	Around Baniya Khora, Pitupura and Dudupura villages, Dist. Sawai Madhopur and Karauli districts, Rajasthan		
	Latitude & Longitude	PROPOSED AREA - Pitupura Block G3 (9.70sq.km) CARDINAL POINTS LATITUDE LONGITUDE A N26° 18' 23.7" E76° 48' 04.5" B N26° 19' 23.1" E76° 49' 20.3" C N26° 21' 37.0" E76° 51' 21.5" D N26° 21' 14.9" E76° 51' 52.0" E N26° 18' 54.1" E76° 49' 51.6" F N26° 17' 53.8" E76° 48' 30.4"		
	Villages	Baniya khora, Pitupura and Dudupura villages		
	Tehsil/ Taluk	Karauli, Sapotra		
	District	Sawai Madhopur, Karauli		
	State	Rajasthan		
2	Area (hectares/square kilometres)	9.7 sq.km.		
	Block Area	9.70 sq. km		
	Forest Area	70%		



	Government Land Area	10% Freehold Govt. Land
	Private Land Area	20% Private (Agriculture)Land
3	Accessibility	The tehsil headquarters, Sapotra, is located about 180 km southeast of the state capital, Jaipur, and is well connected by NH-11B. The area is well connected by a metalled road and provides good transportation. The interior villages are also approachable through a network of metalled, semi-metalled, and Kuchcha jeepable roads.
	Nearest Rail Head	Narayanpur Tatwara, which is about 10 km west of Sapotra.
	Nearest Airport	Maharana Pratap Airport, Udaipur Airport is located 450 Km from Sapotra. well connected by NH27
4	Hydrography	The area is devoid of major rivers. It is mainly drained by the southwesterly flowing Kansil nala, which is an ephemeral nala.
	Local Surface Drainage Pattern (Channels)	The area is also drained by numerous ephemeral streamlets, which are joined by several small nalas.
	Rivers/ Streams	South-westerly flowing Kansil Nala
5	Climate	The climate of the area is semi-arid, with maximum temperature in summer rising up to 41° - 48° C and minimum temperature around 2° - 4° in winter. Severe dust storms are frequent during the summer months.
	Avg. Annual Rainfall	The average rainfall is about 60 cm per annum.
	Temperatures (December) (Minimum)	4°C.
	Temperatures (June) (Maximum)	48 °C.
6	Topography	Mature topography with flat, low-lying hills reduced to its penultimate stage of denudation. The tectonic activities and differential weathering have carved the topography in a series of hills and valleys, which are parallel to the general strike of rocks.
	Topo-sheet Number	54B/15



	Morphology of the Area	The area forms mature undulating topography.
7	Availability of baseline geoscience data	Available details were described in the "Preliminary search of potash in glauconitic sandstone/shale of Vindhyan supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan. (UNFC Stage: G4) December 2019 <i>Annexure 1</i> .
	Geological Map (1:50K/25K)	1:12,500 Scale Map
	Geochemical Map	1:12500 Scale Map
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	NOT AVAILABLE
8	Justification for taking Preliminary Exploration under G3	A. Background Information Singh and Mehta (1977) carried out systematic geological mapping on aerial photos (1:60,000 scale) of Guneshri – Sapotra- Gangapur-Kaila Devi areas of Sawai Mahopur district, Rajasthan, in parts of toposheet nos. 54B/11, 14 & 15. In this area, the rocks of the Vindhyan Supergroup are separated from the main Vindhyan basin along a tectonized contact and lie in the Sapotra Karauli sub-basin. The occurrences of glauconitic sandstone and shale around Alampura, Bariya, and Thulwari villages were reported. The olivegreen shale of Panna and Jhiri Formations is also glauconitic in places, especially near Bapoti and Mahauli villages. Further, GSI, during FS:2015-16 (Mandal & Joy, 2016), carried out an investigation for the search of potash in glauconitic sandstone/shale of the Sapotra-Karauli sub-basin of the Vindhyan Supergroup with the main objective of delineating glauconitic sandstone/shale in the Sapotra-Karauli sub-basin of Vindhyan Supergroup. The authors initiated the work covering an area of 400 sq. km. and after delineating the probable occurrence of glauconite in the northern part of the area, the duo carried out large-scale mapping in a 150 Sq.km area on a 1:12.500 scale and drilled 9 scout boreholes in the area to ascertain the probable occurrence of glauconite mineralisation in the area. Geologically, the GSI explored G4 area consists of the rocks of the Bhilwara Supergroup and Vindhyan Supergroup having tectonic contact in the form of NE-SW trending



Great Boundary Fault (GBF). The Vindhyan group is further classified into lower and upper Vindhyans, and during the large-scale mapping on a scale of 1: 12,500, GSI has delineated glauconitic sandstone/shale in the rocks of the Semri Group of lower Vindhyan and Rewa and Bhander Group of upper Vindhyan. The rocks of the Kaimur Group do not show an indication of glauconite. The Rewa Group of Upper Vindhyan, represented by the rocks of Panna, Indargarh, Jhiri and Taragarh Fort Formations, is important in terms of potash content and spatial distribution of glauconitic sandstone/shale in the study area.

B. Justification:

The chemical analysis of 193 nos. of bedrock samples in the GSI mapped 150 sq. km. indicates that olive green to light green Jhiri shale and Taragarh sandstone contains K2O up to 6.64% (sample JS-80), with an average of 4.50%. On the basis of geological and geochemical results of samples, a total of 08 nos. of glauconitic bearing zones have been delineated. 04 nos. of zones have been delineated in Panna Formation - PMZI-, PMZ-II, PMZ-III & PMZ-IV, having the strike continuity vary from 0.70km to 1.50 km. While in Jhiri Formation, 03 nos. of glauconitic zones have been delineated viz, JMZ-1: from Adadungar to Ramapura Ghati, having strike continuity of about 10 km., JMZ-II: from Gothra to Grain having strike continuity of about 3.0 Km, JMZ-III: near Bajna having strike continuity of about 2.5 km. The proposed block for G3 exploration is along the glauconitic band JMZ1 that extends from Adadungar to Ramapura Ghati, trending NE-SW with a striking continuity of about 10km.

The GSI report of FS:2015-16 in the present area recommends further investigation of the eight mineralised zones for glauconite-bearing potash to assess the potential for exploration. Thus, a preliminary investigation (G3 stage) of potash in glauconitic shale/sandstone of Vindhyan Supergroup has been proposed within the GSI G4 block covering an extent of 9.70 sq. km around Baniya Khora, Pitupura, and Dudupura Villages. The proposed exploratory investigation will involve geological mapping on a 1:10000 scale and systematic exploratory drilling at 950x800m grid in the area (Total 16 BHS) to estimate the resources of potash as per UNFC systems in 333 category.



1.0 BLOCK SUMMARY

1.1.0 Physiography

The proposed block is part of the Survey of India toposheet No. 54B/15 toposheet of scale 1:50,000 covering an area of 9.70 sq. km in Pitupura Block, Sawai Madhopur and Karauli Districts, Rajasthan. Physiographically, around 70% of the area is forest land, about 10% is freehold government land, and the remaining 20% is agricultural land. The area is more or less flat with undulating topography. The area is devoid of major rivers, and the ephemeral streamlets join the southwesterly flowing Kansil nala. The climate is typically a semi-arid environment with peak temperatures during summer, coupled with frequent dust storms. The average rainfall of about 60 cm per annum indicates a moderate amount of precipitation.

1.2.0 Background Geology (Regional Geology, Geology of the Block)

1.2.1 Brief regional geology and structural framework

The regional geological history of the area manifests the rocks of two supergroups, viz., the Bhilwara supergroup and the Vindhyan supergroup (Figure 1). The rocks of the Bhilwara supergroup are represented by litho-units like phyllite and quartzite of Bari Sadri and Hora formations that belong to the Ranthambohr group of Proterozoic age. The rocks of the Vindhyan supergroup include conglomerate, breccia, sandstone, shale, and limestone of the Mesoproterozoic to Neoproterozoic age, which are classified into Semri, Kaimur, Rewa and Bhander groups. The NE-SW trending great boundary fault demarcates the above two supergroups, indicating significant geological activities would have shaped the morphology of the area (Heron, 1917). Further, the development of the Vindhyan basin in the shadow of major geological features like the Bundelkhand granite massifs, Aravalli-Delhi orogenic belts and Satpura orogenic belts further boosts the geological history of the region. The sedimentary litho-units of the Vindhyan supergroup are resting unconformably on the eroded surfaces of the Archean and early proterozoic rocks and are undeformed and unmetamorphosed. This suggests a relatively stable geological environment during the deposition. The lower Vindhyan rocks are predominantly calcareous, whereas the upper Vindhyan rocks are arenaceous, suggesting a temporal change in the depositional environment. The presence of breccia and conglomerates suggests that the region has experienced a complex sedimentation history and tectonic activity. The state of Rajasthan constitutes roughly one-fourth of the total area of the Vindhyan basin. It is developed in two areas, viz, the Chittaurgarh-Mandsaur area and the Sawai Madhopur-Sapotra-Karauli-Dholpur area. The proposed block is part of the second variation. The regional stratigraphy of the region, as coined by Singh and Sinha (1976), is tabulated in Table 1.



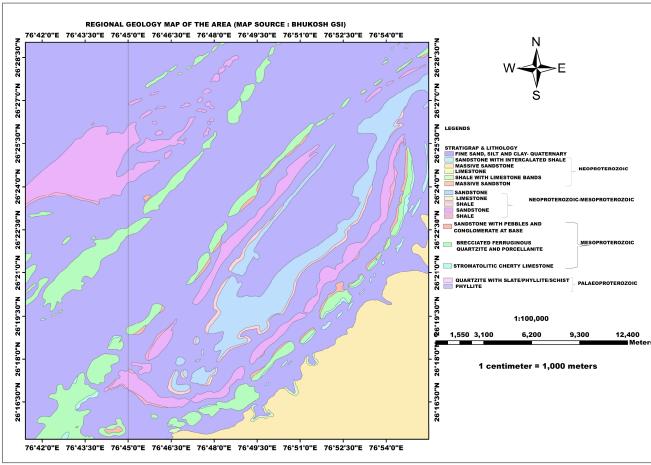


Figure 1: Regional geological map of Vindhyan Supergroup (source GSI BHUKOSH)

The regional structural framework indicates a total of two phases of deformation. The deformations structures are evident in the anticlinal and subsequent synclinal folding between the GBF and its sympathetic faults. The general strike of the litho-units is NE-SW, with a moderate dip towards NW and SE. The primary sedimentary structures like stratification, graded bedding, cross-bedding, ripple marks, mud cracks, etc., reveal the quiet environment during the deposition of the rocks. The rocks of the area also exhibit bedding joints formed due to weathering.



Table 1: Regiona	Table 1: Regional stratigraphy of Sapotra-Karauli sub-basin (After Singh & Sinha, 1976)				
Supergroup	Group	Formation	Lithology	Age	
		Quaternary (unclassified)	Fine sand, silt and clay	Quaternary	
	Bhander	Maihar (Upper Bhander Sandstone)	Massive sandstone, Sandstone with intercalated shale	Neoproterozoic	
		Sirbu	Shale with limestone bands, Limestone		
		Taragarh Fort (Upper Rewa Sandstone)	Sandstone	M	
	Rewa	Jhiri	Shale with limestone	Mesoproterozoic to Neoproterozoic	
Vindhyan	Rewa	Indargarh (Lower Rewa Sandstone)	Sandstone		
Supergroup		Panna	Shale		
	Kaimur	Chittorgarh Fort	Sandstone with Pebbles and Conglomerate at base		
		Tirohan Breccia	Brecciated ferruginous quartzite and porcellanite	Mesoproterozoic	
	Semri	Tirohan Limestone	Stromatolitic cherty limestone	Wesoprocerozoie	
		Tirohan Conglomerate	Conglomerate with grit, sandstone and shale		
Intrusive		Dolerite/meta-dolerite			
Bhilwara	Ranthambhor	Bari Sadri	Phyllite, Quartzite with slate/phyllite/schist	Paleoproterozoic	
		Hora	Quartzite		

1.2.2 Geology of the Block

According to the large-scale mapping carried out by GSI on a scale of 1:12,500, the proposed block consists of glauconite bearing two litho-units, viz., sandstone and shale, belonging to the Rewa group of the Vindhyan supergroup. The sandstone belongs to the Taragadh Fort formation, and the shale



belongs to the Jhiri group. Stratigraphically, sandstone is younger than shale and is said to have been formed during the Mesoproterozoic to Neoproterozoic age (Singh & Sinha, 1976). These two lithounits are overlain by unclassified fine sand, silt and clay of quaternary formation. The block stratigraphy is shown in Table 2.

Table 2: Stratigraphy of the proposed block				
Supergroup	Group	Formation	Litho-unit	Age
		Quaternary	Fine sand, silt	Overtement
		(unclassified)	and clay	Quaternary
		Taragarh Fort		
Vi		(Upper Rewa	Sandstone	Mesoproterozoic
Vindhyan Supergroup	Rewa	Sandstone)		to
		Jhiri	Shale with	Neoproterozoic
			limestone	_

1.2.3 Description of Litho-units

1.2.3.1 Rewa Group

The rocks of Rewa Group occupy the entire proposed block area on the surface. They comprise an alternate sequence of sandstone and shale with occasional limestone.

Jhiri Formation

The litho-unit shale of the Jhiri formation is exposed well in the valley portion and the scrap side of the sandstone of the Taragarh formation and runs parallel to the sandstone trending NE-SW. In the valley portion, it is mostly concealed under alluvium, and on the scarp side, it is covered with scree material, so both upper and lower contact is not comprehensible. In the proposed block, the Jhiri Formation is represented mainly by shale with minor intercalation of siltstone, sandstone, and limestone. GSI during FS:2015-16 highlights that in the proposed block, Jhiri shale is exposed as isolated patches, mostly on the eastern limb of the syncline. In contrast, on the western limb, it is mostly concealed under alluvium and screen material. It is exposed near Gothra and Garain on the western limb of the syncline, while on the eastern limb, it has an isolated outcrop over a strike length of more than 10 km from Adadungar to the north of Ramapura. A limestone horizon is exposed between Bajna and Adadungar area, which is fine-grained, grey to light purple, non-stromatolitic, compact and impure; it lies below the maroon splintery shale.



Figure 2: Olive shale near Bhajna in Jhiri Formation (Image source-GSI: FS 2015-16)



Figure 3: Impure Lime stone with calcite vein near Dudrai, Jhiri Formation (Image source-GSI: FS 2015-16)

Taragarh Fort Formation (Upper Rewa Sandstone)

The rocks of the Taragarh Fort Formation have gradational contact with the underlying Jhiri Formation. It comprises mainly sandstone with occasional intercalation of siltstone and shale. In the study area, it occupies the core of the syncline structure. Geomorphologically, it forms a high linear ridge and saddle landform, especially from Adadungar to Ramapura on the eastern limb. Sandstone is fine to medium-grained, white to buff and pale grey in colour and is made up of quartz (more than 90%) with a subordinate amount of feldspar, tourmaline, magnetite, biotite and, at places, glauconite. The sandstone is moderate to well-sorted and comprises sub-angular to sub-rounded grains of quartz; it is compact and highly jointed. Four sets of joints are recognized, and along the joint and fracture planes, limonite coatings are common. Jointing is regular, and it gives rise to cubical and rectangular blocks; by weathering and erosion, these blocks are often transformed into spherical shapes, especially in the upper part of the formation. Primary sedimentary structures are in abundance in the form of bedding, cross-bedding and ripple marks (both symmetrical and asymmetrical types).



Figure 4: Sandstone shale intercalation in Taragarh formation



Figure 5: Thin bed of glauconitic sandstone near Alampura Manoharpura, in Taragarh formation

(Figure 4 & 5, Image Source GSI: FS:2015-16)

1.2.3.2 Quaternary Sediments

Quaternary sediments are unclassified and comprise sand, silt, and clay in various proportions. The thickness of quaternary sediments ranges from 20 to 30 m in the GSI G4 block. The valley portion mostly consists of alluvial sediments with thicknesses ranging from 1 m to 10 m. According to the Department of Agriculture, Sapotra, Govt. of Rajasthan, the soil of the study area contains very high potash content. The high potash content in the soil may be contributed by weathering and erosion of glauconitic shale/sandstone of the catchment area and its deposition in the valley parts.

1.2.4 Structure and Framework of the Block

The primary sedimentary structures are preserved in almost all the litho units of the Vindhyan Supergroup. The presence of lamination, cross-bedding, graded bedding, mud cracks, and ripple marks is evidence of primary sedimentary structures. Structural elements suggest that the study area has undergone two phases of deformation. The general strike of beds is in the NE-SW direction, with low to moderate dips varying from 800 to 400 towards NW and SE and forming a syncline structure. The tectonic activity gives rise to the development of secondary structures, which is evident in the lithounits of the proposed block by the presence of folds, faults, joints and fractures. The deformational structures are confined mainly between the two major NE-SW trending parallel faults that pass from the eastern and western boundaries of the proposed block. The different structures of the study area are shown in figures tabulated below.



Figure 6: Mesoscopic fold in rocks of Indergarh Formation, quarry section, near Kaontipura. (Image Source: GSI: FS:2016-17)



Figure 7: Faulting in Taragarh sandstone near Gangurda (Image Source: GSI: FS:2016-17)

1.3.0 Mineral Potentiality Based on Geology and Geochemistry

The surface indications of glauconite mineralisation in the area are manifested by the presence of olive green, yellowish green, and olive grey shale from the Jhiri Formation and sandstone of the Taragarh Fort Formation (Figures 14 and 15). The glauconite present here is fine to medium-grained and occurs as thin laminations. In sandstone, glauconite occurs as a dissemination type. In the proposed block, near Bainya Khora, glauconite mineralisation is associated with coarse-grained sandstone and is of disseminated type with patchy occurrence. This indicates that the detrital origin of the litho-units. GSI,



during the FS:2015-16 G4 study, has carried out a detailed geological mapping that demarcated a total of 8 mineralised zones and recommended further exploration. These zones are marked as PMZ-1, PMZ-2, PMZ-3, and PMZ-4 in Panna formation, JMZ-1, JMZ-2 and JMZ-3 in Jhiri formation and TMZ-1 in Taragarh formation. The proposed block is one of the mineralised zones identified by GSI – JMZ1 and belongs to the Jhiri Formation. This mineralised zone extends from Adadungar to Ramapura Ghati with a strike continuity of 10 km. GSI, during the G4 study, has collected 193 samples, and the geochemical analyses project K2O value to range between 0.73% to 6.64% with an average of 4.5%. Out of these 193 samples, GSI has stated that 62 nos. had >5% K2O values. The 3 boreholes (RKS1, RKS2, RKS3) pertaining to this mineralised zone were dug upto a vertical depth of about 35km and were 4km apart. The true thickness of the glauconite bearing zone was 24.5m, 28.5m and 23.3m for RKS1, RKS2 and RKS 3, respectively. The average grade of these three blocks was 5.72%, 5.38% and 5.14%, which is greater than the cutoff of K2O 4.5%.



Figure 8: Lamination of glauconitic sandstone near Dudupura. (Image Source: GSI: FS:2015-16)



Figure 9: Thin band of glauconitic sandstone near Dudupura. (Image Source: GSI: FS:2015-16)

1.4.0 Scope for Proposed Exploration

This project proposes a preliminary survey at the G-3 stage consisting of detailed geological mapping of a 9.70 sq. km. area on a 1:10000 scale; this will be a base map for future work. Drilling 16 nos. of boreholes up to 12800m total depth (800 m each), chemical analysis of the samples, estimation of resources under G3 category and report preparation.

1.5.0 Objectives of Exploration

- Carry out geological and structural mapping on a 1:10000 scale to demarcate Potashbearing zones and associated mineral-bearing formations with structural features to identify the surface manifestations and lateral disposition of the mineralized zones.
- To drill 16 nos. boreholes up to with 800m depth each to prove the strike and depth persistence of glauconite sandstone/shale formation mapped in the area.
- Estimate preliminary resources along with any accessory elements (if any) as per UNFC



norms and minerals (evidence of mineral contents) rules - 2015 at the G-3 level.

1.6.0 Recommendations of GSI G4 Stage Mineral Exploration

The geological and geochemical investigation has established the potash mineralisation in glauconitic shale/sandstone in rocks of the Sapotra- Karauli sub-basin of the Vindhyan Supergroup. The study reveals that potash mineralisation is mainly confined to glauconite-bearing olive shale of the Panna, Jhiri and Taragarh Formations. On the basis of exposure of glauconitic shale, bedrock samples and the analytical result of core samples, a total of 08 nos. of glauconite-bearing shale zones has been delineated. These zones have been marked as PMZ-I, PMZ-II, PM-III & PMZ-IV in the Panna Formation, JMZ-I, JMZ-II & JMZ-III in the Jhiri Formation and TMZ-I in the Taragarh Formation. The appreciable zones of potash-bearing glauconitic rocks have been demarcated for the first time in the Sapotra-Karauli sub-basin of the Vindhyan Supergroup, which opens a new vista for further investigation of potash-bearing glauconitic shale/sandstone in rocks of Vindhyan Supergroup.

On the basis of the investigation, the following recommendations are made by GSI:

- A total of 08 nos. of glauconite-bearing mineralised zones have been demarcated; it is recommended to carry out further investigation (G3 stage) in the glauconite-bearing potash mineralized zones to assess the potentiality of the zones. (GeoExpOre has selected one of the zones for exploration)
- Preliminary investigation (G4 stage) of potash in glauconitic shale/sandstone of Vindhyan Supergroup can be taken in the following areas on the basis of exposure of glauconitic shale/sandstone followed by promising analytical results, which are as follows -
 - 1. Khaidarpur and Bhartun area: Glauconite-bearing Panna shale is exposed in the western extension of the present study area (toposheet no. 54B/11). The analytical results of bedrock samples (L-24) show an appreciable concentration of K2O (4.95%).
 - 2. Kotah and Mach area: Glauconite-bearing Jhiri shale is exposed in the northern extension of the study area (toposheet no. 54B/15). The analytical result of the bedrock sample (L-58) shows an appreciable concentration of K2O (5.34%).
 - 3. Karanpur area: Glauconite bearing Sirbu shale is exposed in toposheet no. 54B/16. The bedrock sample (L-88) 's analytical result shows an appreciable concentration of K2O (4%).
- Glauconitic shale/sandstone with more than 5% K2O concentration can be directly used in acidic soil to enhance soil fertility.

.....



2.0 PREVIOUS WORK

2.1 Previous Exploration details in the proposed block area

- a) Singh and Mehta (1977) carried out systematic geological mapping on aerial photos (1: 60,000 scale) of the Gunesheri - Sapotra- Gangapur-Kaila Devi areas of Sawai Madhopur district, Rajasthan, in the parts of toposheet nos. 54B/11, 14 & 15. In this area, the rocks of the Vindhyan Supergroup are separated from the main Vindhyan basin along a tectonised contact and lie in the Sapotra- Karauli sub-basin. Prior to the G4 study by GSI during FS:2015-16, no mineral exploration work was carried out in the Sapotra-Karauli sub-basin area by the Geological Survey of India. The outcomes of previous geological mapping indicate the occurrences of glauconite in the study area. Dutta et. al., (1976) reported the occurrence of glauconitic sandstone and shale around Alampura, Bariya and Thulwari villages. The olive-green shale of Panna and Jhiri Formations is also glauconitic in places, especially near Bapoti and Mahauli villages. The occurrences of limestone, silica sand, kaolinite, and laterite have been reported in the study area. Tirohan limestone was quarried at the local level to make lime near Kala Devi and Mahauli. Mining of silica sand continues in many places, including the friable sandstone of the Taragarh Formation. An abandoned quarry of laterite has been reported from the sandstone of the Taragarh Formation in the Bajana area. The brick red spotted Maihar sandstone is the prime source of building and decorative stone and is quarried at several localities at a large scale.
- b) GSI, during FS:2015-16 (Mandal & Joy, 2016), carried out an investigation for the search of potash in glauconitic sandstone/shale of the Sapotra-Karauli sub-basin of the Vindhyan Supergroup with the main objective of delineating glauconitic sandstone/shale in the Sapotra-Karauli sub-basin of Vindhyan Supergroup. The authors initiated the work covering an area of 400 sq. km. and after delineating the probable occurrence of glauconite in the northern part of the area, the duo carried out large-scale mapping in a 150 Sq.km area on a 1:12.500 scale and drilled 9 scout boreholes in the area to ascertain the probable occurrence of glauconite mineralisation in the area. Geologically, the GSI G4 area consists of the rocks of the Bhilwara Supergroup and Vindhyan Supergroup having tectonic contact in the form of NE-SW trending Great Boundary Fault (GBF). The Vindhyan group is further classified into lower and upper Vindhyans. During the large-scale mapping on a scale of 1: 12,500, GSI has delineated glauconitic sandstone/shale in the rocks of the Semri Group of lower Vindhyan and Rewa and Bhander Group of upper Vindhyan. The rocks of the Kaimur Group do not show an indication of glauconite. The Rewa Group of Upper Vindhyan, represented by the rocks of Panna, Indargarh, Jhiri and Taragarh Fort Formations, is important in terms of potash content and spatial distribution of glauconitic sandstone/shale in the study area.

.....



3.0 BLOCK DESCRIPTION

3.1 (GSI 2015-16 - 400 SQ. KM AREA)

The coordinates of the corner points of the GSI (G4) area covering 400 sq. km are given in Table 3.

Table 3: GSI G4 AREA (400 sq. km)				
CARDINAL POINTS	LATITUDE	LONGITUDE		
GSI1	N26° 26' 00.0"	E76° 50' 57.0"		
GSI2	N26° 26' 00.0"	E76° 57' 57.0		
GSI3	N26° 15' 00.0"	E76° 47' 30.0		
GSI4	N26° 17' 30.0"	E76° 42' 30.0"		

3.2 (GSI 2015-16 - 150 SQ. KM AREA)

Table 4 gives the coordinates of the corner points of the GSI (G4) area covering 150 sq. km.

Table 4:	GSI G4 AREA (15	0 sq. km)
CARDINAL POINTS	LATITUDE	LONGITUDE
A	N26° 26' 00.0"	E76° 50' 57.0"
В	N26° 26' 00.0"	E76° 57' 57.0
С	N26° 07' 30.0"	E76° 37' 38.0"
D	N26° 07' 30.0"	E76° 30' 00.0"

3.3 Proposed G3 investigation area

The area falls under Survey of India Toposheet no. 54B/15 and covers about 9.70 sq. km. Localities present in the vicinity include Baniya Khora, Pitupura, and Dudupura villages. The coordinates of the proposed Pitupura block's corner points are given in Table 5 below.

Table 5: Pl	ROPOSED AREA - Pitup	oura Block (9.70sq.km)
CARDINAL POINTS	LATITUDE	LONGITUDE
A	N26° 18' 23.7"	E76° 48' 04.5"
В	N26° 19' 23.1"	E76° 49' 20.3"
С	N26° 21' 37.0"	E76° 51' 21.5"
D	N26° 21' 14.9"	E76° 51' 52.0"
Е	N26° 18' 54.1"	E76° 49' 51.6"
F	N26° 17' 53.8"	E76° 48' 30.4"



4.0 PLANNED METHODOLOGY

The exploration program has been proposed in accordance with the objective set for the preliminary survey (G-3) of the block. The Exploration shall be carried out as per Minerals (Evidence of Mineral Contents) Rule-2015 and Minerals (Evidence of Mineral Contents) Amendment Rules-2021. Accordingly, the following scheme of exploration is formulated to achieve the objectives. The details of the different activities to be carried out are presented in the following paragraphs.

Geological Mapping (1:10000 Scale)

Geological mapping will be done on the entire 9.70 sq. km. area on 1: 10000 scales. Rock types, their contact, and demarcation of mineral deposits and associated mineralization-bearing formations (host rock) with the structural features to identify the surface manifestations and lateral dispositions of the mineralized zones.

Surveying

The block boundary will be surveyed by DGPS, and the total station in the WGS-84 datum will be used for the demarcation of proposed area boundary points. The survey party will also carry out surface features and contouring in the proposed area, which will be associated with geological activities for taking up locations of outcrop. Further, during the drilling programme, the survey party will carry out borehole fixation and determination of the reduced levels and coordinates of the proposed 16 nos of boreholes following the 950x800m grid.

Geophysical Survey

The block's area is 9.70 sq. km. and, in general, is more or less plane land with some undulations. The majority of the area is under cultivation with few hillocks. During the drilling programme, various geophysical techniques such as Dual density, Nuetron, Resistivity, Spectral Gamma, and Caliper logging will be used in all the boreholes to identify the potash-bearing zones and sample them.

Core Drilling

To determine the continuity of mineralised zones in strike and dip direction, a total of sixteen (16 nos.) vertical boreholes shall be drilled over the mineralised zone in a grid pattern of 950m X 800m along the strike and dip direction to prove the mineralisation. Total drilling meterage of 12800m, with 800m depth in each borehole.

Drill Core Logging

The borehole core will be systematically logged for rock types, structural features, textures, intersection of ore zones, types of mineralisation, and the occurrence of various ore minerals. Logging for the determination of Rock Quality Designation/determination (RQD) will also be carried out.



Drill Core Sampling

During the geological logging of drill cores, mineralised zones will be marked on the basis of the concentration of ore minerals and lithology. A total of 2400 nos. primary and 360 nos. check (15%) samples will be analysed for potash and associated Mineralization. A total of 16 samples shall be subjected to XRD studies for the determination of trace elements.

Specific Gravity Determination

Specific Gravity will be determined for 16 samples from the mineralised zones intersected in the boreholes.

Estimation of resources

Estimate resources according to UNFC norms and the Minerals Evidence & Mineral Contents(MEMC) Rule—2015 at the G-3 level and meet the NMET objectives.

Report preparation

Submission of reports and recommendations in compliance with G3 level as per MEMC 2021 and suggestions for follow-up work to upgrade the project, if deemed necessary.

5. NATURE, QUANTUM AND TARGET

The nature and quantum of work proposed are given in Table 6.

Table 6: The nature and quantum of work proposed

S. No.	Activity	Unit	1	2	3	4	5	6	7	8	9	10	11	12		13	14	15	16	17	18
1	Camp Setting	Month		8			- 39	8			- 37						8			8 8	
2	Core Drilling (4rigs)	Month	100												R						\Box
3	Gological Party Days	Day													E						П
4	Sampling Party Days/ Core Sampling	Day													V					9 8 8 9	
5	Camp Wininding	Day													E						\Box
6	Laboratory Studies	Month	T.												W						
7	Geological Party Days (HQ)	Day	48	0 0		80 .00		. 8		- 3			72 V				20	- 1			
8	Report Writing & Peer Review	Day	16	9 9		9 3	- 93	9	- 8	- 8	1 12		9 3	1 8			9 9	23		4	



5.1 Nature and Quantum of Work Proposed

Table 7: Nature and quantum of work for Preliminary Exploration (G3 stage) for Potash and Associated Minerals in Pitupura Block, Dist.: Sawai Madhopur and Karauli, Rajasthan

	Total Area 9.70 <u>Sq.Km</u> (Mapping on1:10000 Scal		
Sl.No	Item of work	Unit	Qty
1	Geological Mapping on 1:10000 Scale	sq. km.	9.70
2	DGPS Survey of 16 nos. of BHS, 1 Base Station,	Nos	17
3	Drilling 16 Boreholes on 950mX800m grid	m	12800
4	Geophysical Studies		
	i) Borehole geophysical logging Dual Density, Resistivity, Spectral Gamma, Neutron and Caliper	m	12800
5	Laboratory Studies	Days	120
a	Primary Samples for 12 radicals, i.e., K, Na, Mg, Cl, Br, I, Li, CaSO4 and water-insolubles	Nos.	2400
b	Check samples (15% of Primary samples) for 12 radicals, i.e., K, Na, Mg, Cl, Br, I, Li, CaSO4 and water insolubles	Nos.	360
c	X-ray diffraction studies	Nos.	16
6	GEOTECHNICAL STUDIES		
	Specific Gravity Determination	Per Sample	16

6. MANPOWER DEPLOYMENT

Manpower requirement: The Total Geological activity shall be for 18 months (16 months in the field and two months for report writing), which includes 2 senior geologists and 2 junior geologists, 1 Surveyor, 2 sampling technicians, 1 Geophysicist, 1 Geochemist, and 1 4 labourers. Exploratory Drilling Activities.

7. BREAK-UP OF EXPENDITURE:

The cost estimate for the G3 exploration is given in Table 8.



Cost Estimate - Title: Preliminary Exploration (G3 Stage) for POTASH and Associated Minerals in Pitupura Block, Dist: Sawai Madhopur and Karauli RAJASTHAN,

Area 9.70 sq. km, No.of BH: 16, Borehole depth: 800m; Timeline-18 months Review: After 12 Months

				per NMET 2020-21	1	ed Cost of the Proposal
S. No.	Item of Work *	Unit*	SoC- Item No. *	Rates as per SoC * (a)	Qty. (b)	Total Amount (Rs) (a*b)
A	Geological Mapping Other Geological W	ork & Surveyi	ng			
	Geological mapping, (1:10,000 scale) & , I	Drilling, Borehol	le logging, l	Report Writing	3	
i	Charges for Geologist per day (Field) for geological mapping drilling work	day	1.3	11,000	360	39,60,000
ii	Labours Charges; Base rate	day	5.7	504	720	3,62,880
Iii	Charges for Geologist per day (HQ)	day	1.3	9,000	60	5,40,000
Iv	Charges for one Sampler per day (1 Party)	one sampler per day	1.5.2	5,100	300	15,30,000
V	Labours (4 Nos)	day	5.7	504	1,200	6,04,800
	Sub Total- A					69,97,680
В	Survey work					
a	DGPS Survey for BH fixation & RL determination of the Boreholes and 1 no of Base Station	Per Point of observation	1.6.2	19,200	17	3,26,400
b	Charges of Surveyor (1 party) for Geophysical survey layout work & Block boundary demarcation	one surveyor per day	1.6.1a	8,300	210	1743000
c	Labours Charges for survey work;	day	5.7	504	840	423360
	Sub-Total B					24,92,760
E	DRILLING (950mx800m grid)					
1	Drilling up to 300m (Hard Rock)	m	2.2.1.4a	11,500	4,800	5,52,00,000
2	Drilling up to 600m (Hard Rock)	m	2.2.1.4b	12,420	4,800	5,96,16,000
3	Drilling up to 800 m (Hard Rock)	m	2.2.1.4c	13,225	3,200	4,23,20,000
4	Land / Crop Compensation (in case the BH falls in agricultural Land)	per BH	5.6	20,000	16	3,20,000
5	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2,000	16	32,000
6	Borehole plugging by cement	m	2.2.7b	150	12,800	19,20,000



7	Transportation of Drill Rig & Truck associated per drill (2 rigs)	Km	2.2.8	36	7,200	2,59,200
8	Monthly Accommodation Charges for drilling Camp (4 rigs 50000 +(50000X50%)X2)=100000)	month	2.2.9	1,00,000	18	18,00,000
9	Drilling Camp Setting Cost	Nos	2.2.9a	2,50,000	4	10,00,000
10	Drilling Camp Winding up Cost	Nos	2.2.9b	2,50,000	4	10,00,000
11	Road Making (Flat Terrain)	Km	2.2.10a	22,000	5	1,10,000
12	Drill Core Preservation	per m	5.3	1,590	2,600	41,34,000
	Sub Total B					16,77,11,200
C	BOREHOLE GEOPHYSICAL LOGGING					
1	Dual Density	m	3.11d	102	12,800	13,05,600
2	Spectral Gamma	m	3.11o	164	12,800	20,99,200
3	Resistivity	m	3.11c	39	12,800	4,99,200
4	Neutron	m	3.11f	74	12,800	9,47,200
5	Caliper	m	3.11g	19	12,800	2,43,200
6	Expert Charges for Geophysicist HQ	day	3.18	9,000	30	2,70,000
7	Expert Charges for Geophysicist Field	day	3.18	11,000	60	6,60,000
	Sub Total C					60,24,400
D	LABORATORY STUDIES					
1	Chemical Analysis					
i)	Primary Samples					
	Analysis of 12 radicals - quantitative chemicals analysis by conventional wet chemical analysis method K, Na, Water Insolubles,, Mg, Cl, Br, I, Li & CaSo4	Nos	4.1.1	8,157	2,400	1,95,76,800
ii	External Check Samples (15%)	Nos				
	Analysis of 12 radicals - quantitative chemicals analysis by conventional wet chemical analysis method K, Na, Water Insolubles,, Mg, Cl, Br, I, Li & CaSo4	Nos	4.1.1	8,157	360	29,36,520
viii	XRD analysis for identification of minerals random	nos	4.5.1	4,000	16	64,000
	ļ	I			1	



	Sub Total D					2,25,77,320
2	Specific Gravity Determination					
	Specific Gravity Determination	nos	4.8.1	1605	16	25,680
	TOTAL (A to D)					20,58,29,040
E	Geological Report Preparation	5 Hard copies with a soft copy	5.2	If project cost is more than 300lakhs then Max 20lac will be allowed	1.00	20,00,000
F	Peer review Charges		As per EC decision			30,000
G	Preparation of Exploration Proposal (5 Hard copies with a soft copy)	5 Hard copies with a soft copy	5.1	2% of the Cost or Rs. 3.8 Lakhs whichever is less		3,80,000
Н	Total Estimated Cost without GST					20,82,39,040
I	Provision for GST (18% of H)					3,74,83,027
J	Total Estimated Cost with GST					24,57,22,067
				or Say Rs.	In Lakhs	2,457.22

8. REFERENCES

Dutta, Singh and Sinha., (1976): Report on the Geology of Noroli, Karauli, Hindaun- Masalpar area of Bharatpur- and Sawai Madhopur districts, Rajasthan. Unpublished GSI report for F.S. 1974-75.

Heron, (1917). The geology of north-eastern Rajputana and adjacent districts, Mem. Geol. Surv. Ind. (45).

Mandal and Joy (2016). Preliminary search of Potash in Glauconitic sandstone/shale of Vindhyan supergroup exposed in parts of Sawai Madhopur and Karaulic districts, Rajasthan. GSI unpublished report during FS:2015-16.

Singh and Mehta, (1977). A report on the geology of Gunesheri- Sapotra-Gangapur-Kailadevi areas of Sawai Madhopur district, Rajasthan. GSI unpublished Prog. Rep. for FS: 1975-76.

PLATE-1
PROPOSED G3 AREA FOR POTASH AND ASSOCIATED MINERALS OVER GEOLOGICAL MAP 1:50,000 SCALE WITH LOCATION INDEX IN PITUPURA BLOCK, SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN

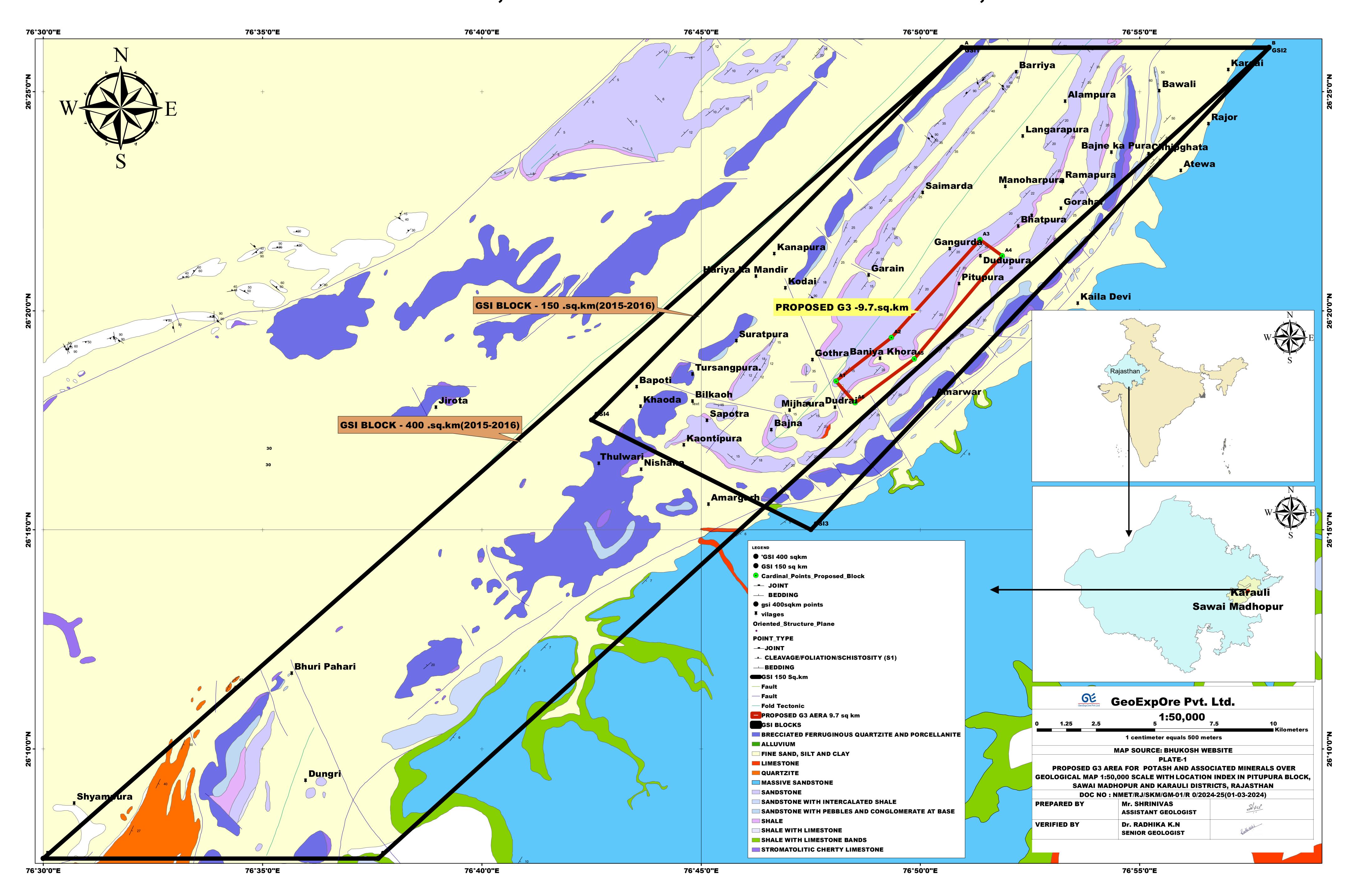


PLATE-2
PROPOSED G3 AREA FOR POTASH AND ASSOCIATED MINERALS OVER GEOLOGICAL MAP 1:50,000 SCALE WITH SAMPLE LOCATION IN PITUPURA BLOCK, SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN

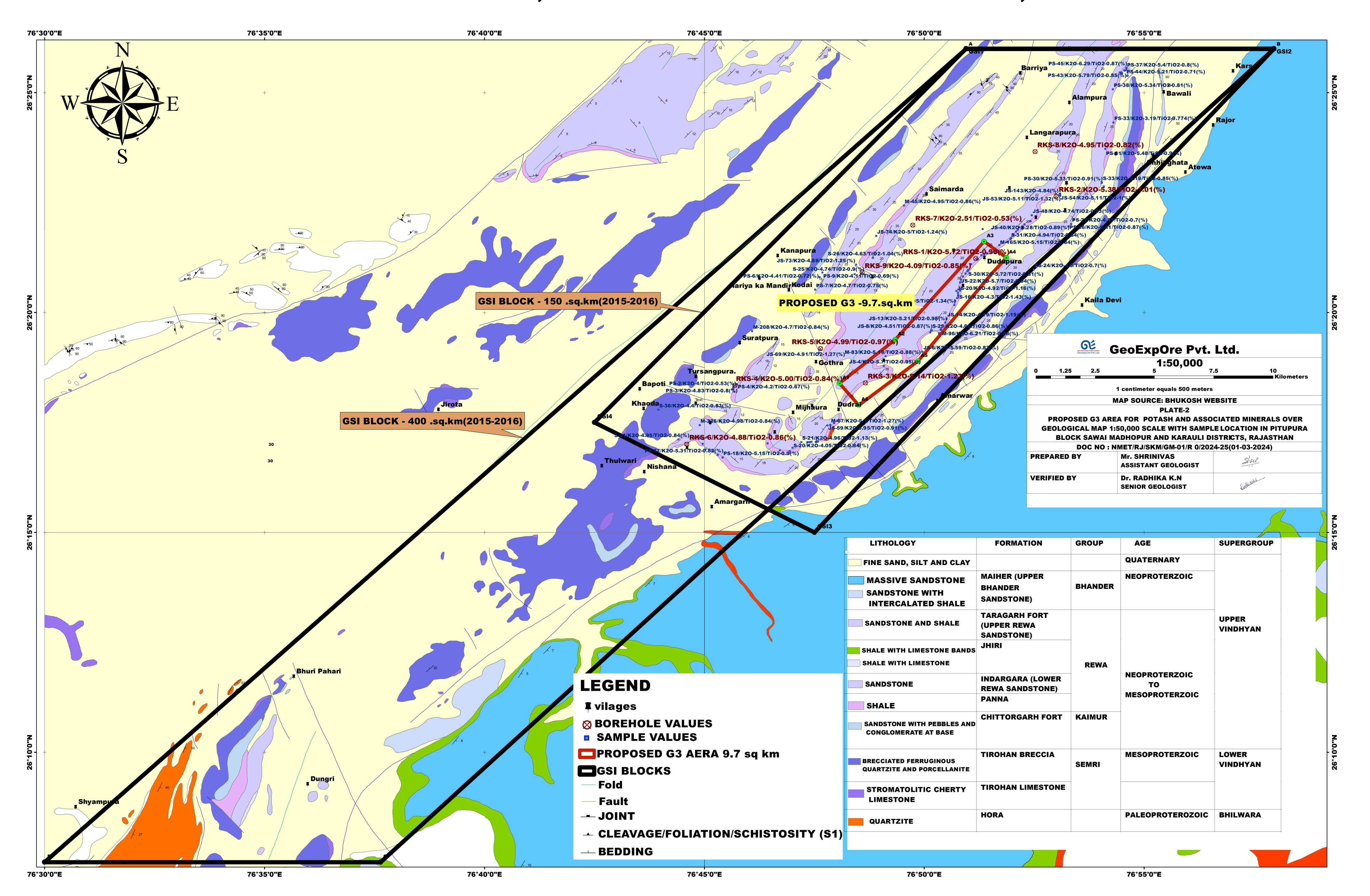


PLATE-5

PROPOSED G3 AREA FOR POTASH AND ASSOCIATED MINERALS OVER GEOLOGICAL MAP 1:12,500 SCALE IN PITUPURA BLOCK, SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN

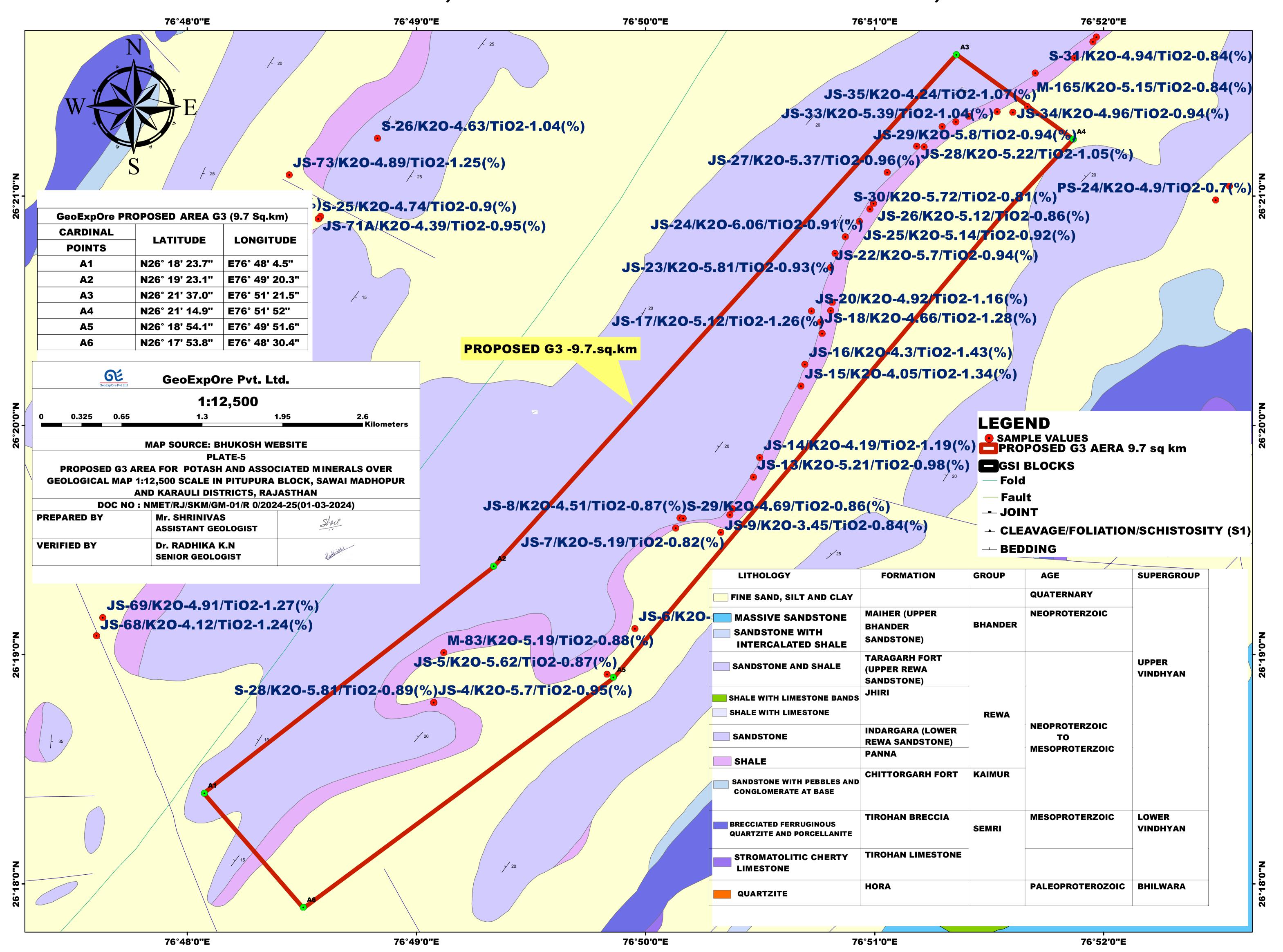


PLATE-7 TENTATIVE BOREHOLE LOCATIONS PROPOSED G3 AREA FOR POTASH AND ASSOCIATED MINERALS 1:12,500 SCALE IN PITUPURA, SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN

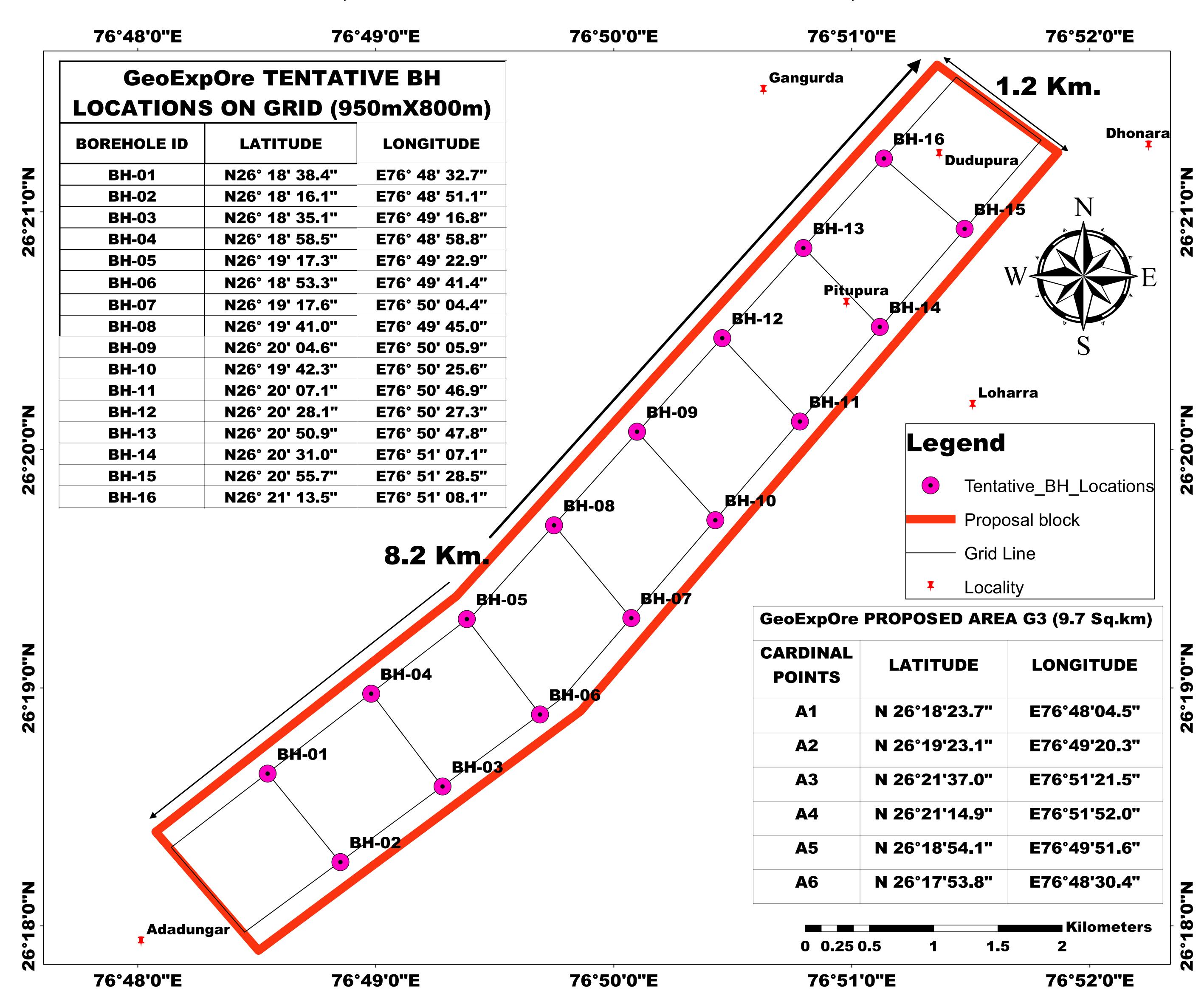
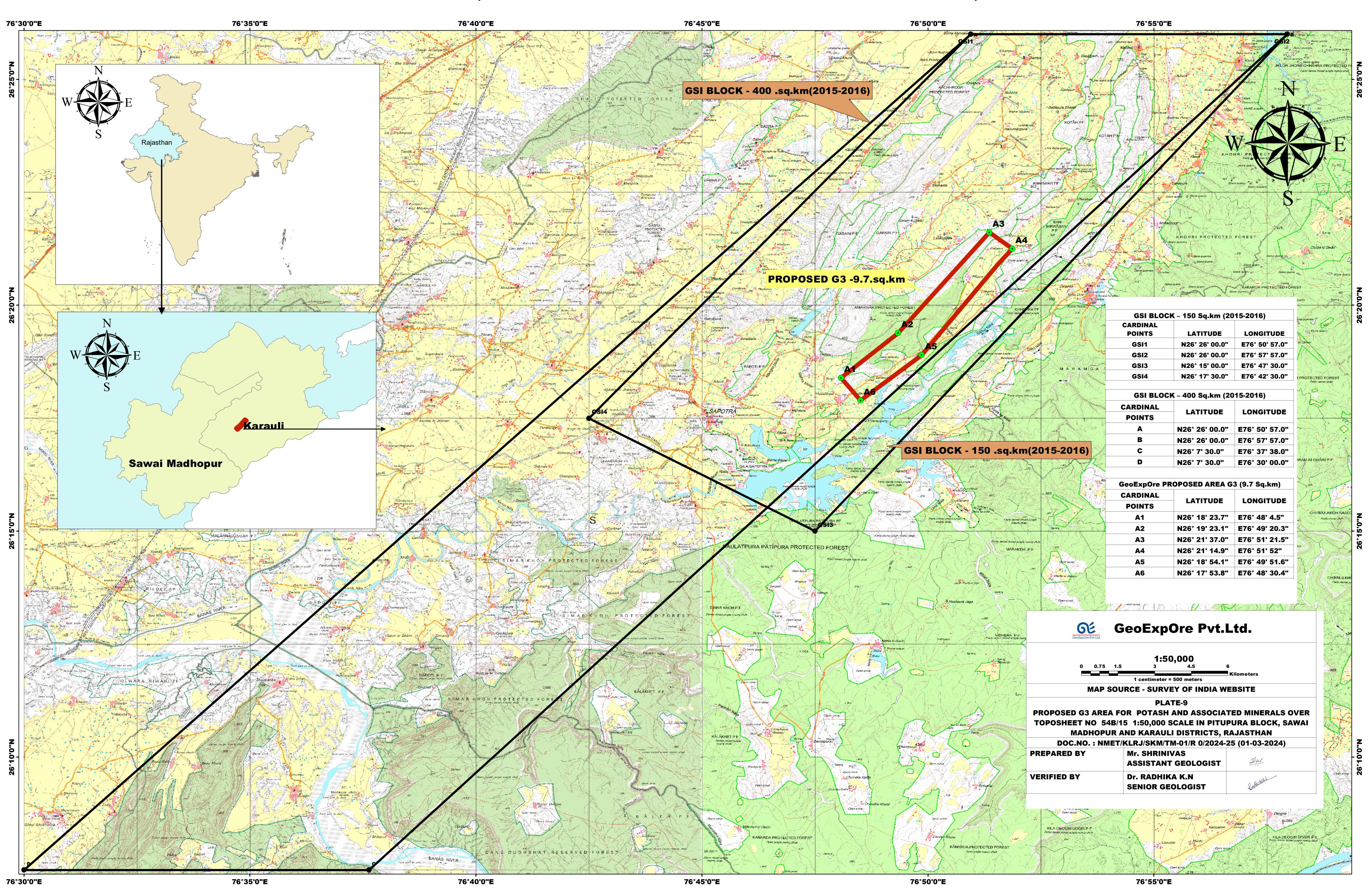


PLATE-9
PROPOSED G3 AREA FOR POTASH AND ASSOCIATED MINERALS OVER TOPOSHEET NO 54B/15 1:50,000 SCALE
IN PITUPURA BLOCK, SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN



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श्रेणी — सीमित वितरण प्रतिवेदन Category – Limited Circulation Report

भारत सरकार GOVERNMENT OF INDIA

भारतीय भूवैज्ञानिक सर्वेक्षण GEOLOGICAL SURVEY OF INDIA



राजस्थान के सवाई माधोपुर तथा करौली जिले के भागों में उद्ग्रासित विन्ध्यन महासमूह के ग्लूकोनाइटीक बालूकाश्म/शेल में पोटाश का प्रारंभिक खोज

PRELIMINARY SEARCH OF POTASH IN GLAUCONITIC SANDSTONE/SHALE OF VINDHYAN SUPERGROUP EXPOSED IN THE PARTS OF SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN.

(Final Report for the F.S. 2015-16) (Item No.56, FSP Code. ME/WR/RAJ/2015/049)

मुकेश कुमार मंडल, भूवैज्ञानिक जॉय एस, भूवैज्ञानिक

Mukesh Kumar Mandal, Geologist

Joy. S, Geologist

परीयोजना : उर्वरक खनिज मिशन—IIए राज्य इकाई : राजस्थान

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Mission-IIA
State Unit Rajasthan
Western Region, Jaipur

नवम्बर, 2016 November, 2016

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PRELIMINARY SEARCH OF POTASH IN GLAUCONITIC SANDSTONE/ SHALE OF VINDHYAN SUPERGROUP EXPOSED IN THE PARTS OF SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN.

(UNFC: G-4 STAGE) Item No.56, FSP Code. ME/WR/RAJ/2015/049 (Final Report for the Field Season 2015-2016)

By Mukesh Kumar Mandal & Joy. S, Geologist

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राजस्थान के सवाई माधोपुर तथा करौली जिले के भागों में उद्घासित विन्ध्यन महासमूह के ग्लूकोनाइटीक बालूकाश्म/शेल में पोटाश का प्रारंभिक खोज

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अध्याय-1

सारांश

भारतीय भूवैज्ञानिक सर्वेक्षण, पश्चिमी क्षेत्र के वार्षिक कार्यक्रम 2015-16 की मद संख्या-56 के अनुक्रम में विन्ध्यन महासमूह के सापोटरा-करौली सब-बेसिन में ग्लेकोनिटिक बालूकाश्म/शेल में पोटाश के खोज के लिए यू.एन.एफ.सी. जी-4 चरण अन्वेषण किया गया। अध्ययनांतर्गत क्षेत्र भारतीय सर्वेक्षण की टोपोशीट संख्या 54B/11,12 और 15 के अंतर्गत है जो कि राजस्थान के सवाई माधोपुर और करौली जिलों में फैली हुई हैं। कुल 400 वर्ग किमी का यह क्षेत्र क्षेत्र किर्देशांकों-A-26°26'00''-76°50'57'', B-26°26'00''-76°57'57'', C- 26°07'30''-76°37'38'' तथा D- 26°07'30''-76°30'00'' द्वारा आबद्ध है। एल.एस.एम. क्षेत्र टोपोशीट संख्या 54B/11 तथा 15 के हिस्सों में फैला हुआ है और निर्देशांकों A-26°26'00''-76°50'57'', B-26°26'00''-76°57'57'', C-26°15'00'' -76°47'30'' और D-26°17'30''-76°42'30'' द्वारा आबद्ध है। इस कार्य का प्रमुख उद्देश्य विंध्यन महासमूह के सापोटरा करौली सब बेसिन में ग्लेकोनिटिक अश्म इकाईयों की खोज और वर्णन करना था।

400 वर्ग किमी. क्षेत्र का 1:50,000 पैमाने पर एक क्षेत्रीय फोटो व्याख्या मानचित्र तैयार किया गया है। 150 वर्ग किमी. क्षेत्र का 1:12,500 पैमाने पर वृहत पैमाना मानचित्रण किया गया। पृष्ठ गवेषण के एक भाग के रूप में 323 संस्तर शैल नमूनें और 80 पिटिंग/टैंचिंग नमूने संकलित किए गए। 09 स्काउट वेधन छिदों में 300 मीटर स्काउट ड्रिलिंग में से 255 कोर नमूनों की प्रहार निरंतरता और ग्लेकोनिटिक शेल का गहराई अवस्थित बालूकाश्म निरूपण करने के लिए विश्लेषण किया गया तथा वृहत पैमाना मानचित्रण में दर्ज किया गया। संकलित किए गए 37 शैल नमूने जो भिन्न-भिन्न अश्म इकाईयों को निरूपित करते हैं, का शैलिकी अध्ययन किया गया। 05 शैल/खिनज नमूने भी संकलित कर XRD विश्लेषण हेत् भेजे गए।

इस क्षेत्र का क्षेत्रीय भूविज्ञान पालीओ प्रोटेरोजोइक काल के भीलवाड़ा महासमूह के शैलों और मेसोप्रोटेरोजोइक से नीओप्रोटेरोजोइक काल के विन्ध्य महासमूह के शैलों द्वारा व्यक्त हुए हैं। ये ग्रेड बाउंड्री फॉल्ट (GBF) के साथ NW-SE उन्मुखी रूप में विवर्तनिकी संस्पर्शवस्था में हैं। वृहत पैमाना मानचित्रण का क्षेत्र दक्षिण पश्चिम में सापोटरा से उत्तर पूर्व में महौली तक विस्तारित हो रहा है, और यह क्षेत्रीय प्रहार अर्थात NE-SW के समानांतर प्रहार लंबाई 26 किमी. पर है। यह क्षेत्र निचले और ऊपरी दोनों प्रकार के विंध्य शैलों से युक्त है। वृहत पैमाना मानचित्रण के दौरान ग्लेकोनिटिक बालूकाश्म/शेल निचले विंध्य के सेमेरी समूह से जबिक ऊपरी विंध्य के रीवा और भण्डेर समूह से दर्ज किए गए हैं।

सेमेरी समूह से महौली के निकट पहली बार ग्लेकोनिटिक बालूकाश्म का एक समूह दर्ज किया गया है। कैम्र समूह के शैल ग्लेकोनाइट खनिजायन का संकेत नहीं देते। ऊपरी विंध्य का रीवा समूह जो कि पन्ना, इंदरगढ़, झीरी और तारागढ किला संरचनाओं के शैलों द्वारा निरूपित है, अध्ययन क्षेत्र में पोटाश संधारण तथा ग्लेकोनिटिक बालूकाश्म/शैल के क्षेतिज वितरण के दृष्टिकोण से महत्वपूर्ण है। पाना संरचना के जैतून हरित शेल ग्लेकोनाइट संधारण के विविध अनुपातों, अपनी कुल खनिज संधरण के 80 से 30% तक के अनुपात से युक्त है। 76 सं तर शैल गमूनों के रासायनिक विश्लेषण द्वारा यह संकेत मिला है कि हल्के हरे से पीले रंग के शेल K20 के अधिकतम संधारण 7.21% तक (गमूना संख्या पी-36), जिसकी औसत गुणवत्ता 5.08% है। पन्ना शेल में स्काउट बोरहोल (RKS-4&6) का वेधन किया गया जिसने K20 संधारण के औसत श्रेणी के क्रमश 5.2 और 4.75% की उपस्थित दर्शाई है।

अध्ययन क्षेत्र में इंदरगढ़ संरचना के बालूकाश्म में ग्लेकोनाइट खिनजायन के कोई संके त नहीं मिले हैं। झिरी संरचना मुख्यतः शेल के साथ बालुकाश्म /िसल्टस्टोन के न्यून अनुपात के साथ निरूपित है। ग्लेकोनाइट बालुकाश्म /िसल्ट स्टोन की उपस्थिति पहली बार रामपुरा और भाटपुरा में दर्ज की गई। 194 सं तर शैल नमूनों के रासायनिक विश्लेषण से पता चला है कि जैतून हरित से हल्के हरे शेल संधारित अधिकतम K_2O सांद्रण 6.64% तक (नमूना JS-80) औसत गुणवत्ता 4.5% होने के संके ति मिले हैं। गहन अवस्थिति और प्रहार निरंतरता सुनिश्चित करने के लिए 0.5 छिछले स्काउट वेधन छिद्रों (RKS-1,2,3,5,&9) के वेधन अधिकतम 45 मीटर गहराई तक किया गया। मौजूदा अध्ययन के दौरान ग्लेकोनाइट खिनजायन तारागढ़ किला संरचना से गराइन के निकट गगूरडा और मोहन पुरा से पहली बार दर्ज किया गया है। ग्लूकोनाइट मध्यम से स्थूल चूर्णित बालुकाश्म के सहयोजी रूप में है यह बारीक लेंसों और कहीं कहीं पर प्रकीर्णित रूप में उपस्थित है। ग्लूकोनाइट का सांद्रण कुल ,खिनज संधारण के 10 के 30% के मध्य परिाखर्तित हो रहा है। संस्तर शैल नमूनों में K_2O संधारण मात्र 2 से 3% के मध्य है।

तारागढ़ संरचना के बालूकाश्म में स्काउट वेधन छिद्रों (RKS-7&8) का अधिकतम 30 मीटर गहराई तक वेधन किया गया। अध्ययनां तर्गत क्षेत्र की मैहर संरचना ईंट जैसी बालूकाश्म द्वारा निरूपित है। ग्लेकोनाइट बालूकाश्म की एक बारीक गांठ की उपस्थिति खरसाई, राजोर और अटेवा के निकट खदान खण्ड में दर्ज की गई है। नमूनों का K_2O संधारण अधिकतम 0.23% है जो उत्साह वर्धक नहीं है।

नमूनों के भूवैज्ञानिक और भूरासायनिक विश्लेषणों के आधार पर कुल 08 संभागों का आगे अनुसंधान हेतु व्याख्यायित किया गया है। इनमें 04 संभागों को पाना संरचना के अंतर्गत चिह्नित किया गया यथा कनोटीपुरा के निकट PMZ-1 जिसकी प्रहार निरंतरता लगभाग 1.5 किमी बापोती के निकट PMZ-2 जिसकी प्रहार निरंतरता 07 किमी. कोडई के निकट PMZ-3 जिसकी प्रहार निरंतरता 1.0 किमी. माहौली में PMZ-4 जिसकी प्रहार निरंतरता 01 किमी. है। इसी प्रहार झिरी संरचना में 03 संभागों यथा अडाडूगर रामपुरा घाटी तक JMZ-I, जिसकी प्रहार निरंतरता लगभग 10 किमी., गोठारा से ग्रैन तक JMZ-II जिसकी प्रहार निरंतरता लगभग 03.0 किमी. बजना के निकट JMZ- III जिसकी प्रहार निरंतरता लगभग 2.5 किमी. है। एक संभाग तारागढ़ संरचना में लंगरपुरा के निकट TMZ-I चिन्हिनत किया गया जिसकी प्रहार निरंतरता 1 किमी. है।

पोटाश (K_2O) संशाधन की गणना 08 स्काउट वेधन छिद्रों के क्रोड नमूनों के विश्लेषणात्मक परिणामों तथा ग्लूकोनाइटिक शेल/बालूकाश्म की उद्धासित लम्बाई के आधार पर किया गया। K_2O के 4.5% कट ऑफ श्रेणी की परिकल्पना करते हुए अनुप्रस्थ काट पद्धित द्वारा संशाधन की गणना की गई। 5.30% K_2O के औसत श्रेणी के साथ K_2O का आवीक्षण संशाधन 57.45 मिलियन टन है जो उत्साह जनक है।

विंध्यन महासमूह के सपोटरा-करौली उप-द्रोणि में पहली बार ग्लूकोनाइटिक शैलमय पोटाश के अवगम्य अंचलों का सीमांकन किया गया तथा विंध्यन महासमूह के शैलों में ग्लूकोनाइटिक शेल/बालूकाश्म मय पोटाश के अग्रिम अन्वेषण के लिए एक नवीन विस्टा खोला गया। अन्वेषण के आधार पर पोटाश के अग्रिम G3 चरण के गवेषण लिए क्षेत्रों को चिन्हित किया गया तथा पोटाश के G4 चरण के गवेषण की सिफारिश की गई।

CHAPTER-1

SUMMARY

In pursuance of field season program of 2015-16, Item No.56, FSP Code. E/WR/RAJ/2015/049 of GSI, WR, an investigation has been carried out for the search of potash in glauconitic sandstone/shale of Sapotra-Karauli sub-basin of Vindhyan Supergroup. The study area is located in Survey of India toposheet no. 54B/11, 12 and 15, covering parts of Sawai Madhopur and Karauli districts, Rajasthan. The total 400 Sq.km. area is bounded by coordinates A -26°26′00" - 76°50′57", B-26°26′00" - 76°57′57", C- 26°07′30"- 76°37′38" and D- 26°07′30" - 76°30′00". The LSM area is covering parts of toposheet no 54B/11 & 15 and bounded by coordinate A -26°26′00" - 76°50′57", B- 26°26′00" - 76°57′57", C- 26°15′00" - 76°47′30" and D- 26°17′30" - 76°42′30". The main objective was to search and delineate glauconitic sandstone/shale in Sapotra-Karauli sub basin of Vindhyan Supergroup.

Aerial photo interpretation map of 400 Sq.km area on 1:50,000 scale was prepared. The Large Scale Mapping (LSM) of 150 Sq. km area was carried out on 1:12,500 scale. As a part of prospecting 323 nos. of bed rocks samples and 80 nos. of pitting/trenching samples were collected to delineate bands of glauconitic sandstone and shale. A total of 255 nos. of core samples were analyzed out of 300 m scout drilling in 09 scout boreholes in order to check strike continuity and depth persistence of the glauconitic shale and sandstone. 37 nos. of rock samples representing different litho units of the area were collected for petrographical study. 05 nos. of rocks/mineral samples were also collected and submitted for XRD analysis.

Regional geology of the study area is manifested by the rocks of Bhilwara Supergroup and Vindhyan Supergroup. These are having tectonic contact in the form of NE-SW trending Great Boundary Fault (GBF).

The Large Scale Geological Mapping area extends from Sapotra in southwest to Mahauli in northeast, over a strike length of 26 km parallel to regional strike i.e. NE-SW. The area comprises rocks of both the lower and upper Vindhyan. During the large scale mapping glauconitic sandstone/shale has been delineated in

the rocks of Semri Group of lower Vindhyan, Rewa and Bhander Group of upper Vindhyan.

A band of glauconitic sandstone is reported, first time, from Semri Group, near Mahauli. The rocks of Kaimur Group do not show indication of glauconite. The Rewa Group of Upper Vindhyan, represented by the rocks of Panna, Indargarh, Jhiri and Taragarh Fort Formations, is important in terms of potash content and spatial distribution of glauconitic sandstone/shale in the study area. Olive green shale of Panna Formation contains glauconite in various proportions that ranges from 90 to 30% of its total mineral content. Chemical analysis of 76 nos. of bed rock samples indicates that light green to yellow Panna shale contain average K₂O 5.08 %. Scout boreholes (RKS-4 & 6) were drilled in Panna shale, core samples of these scout boreholes analyzed, average grade of K₂O content 5.2% (RKS-4) and 4.75 % (RKS-6), respectively. There is no indication of glauconite in the sandstone of Indargarh Formation in the study area. Jhiri Formation represented by mainly shale with minor proportion of sandstone/siltstone. Glauconitic sandstone/siltstone is reported in Jhiri sandstone/siltstone around Ramapura and Bhatpura. Chemical analysis of 193 nos. of bed rock samples indicates that olive green to light green Jhiri shale contain K_2O up to 6.64% (sample JS-80), with an average of 4.50%. To ascertain depth persistence and strike continuity, 05 nos. of shallow scout boreholes (RKS-1, 2, 3, 5 & 9) were drilled, up to maximum depth of 45m. During the present study glauconitic sandstone is reported from Taragarh Fort formation, near Garain, Gangurda and Manoharpura. In Taragarh Fort Formation, glauconite is associated with medium to coarse grained sandstone. It occurs as thin lenses and disseminated at places. Bed rock samples having K₂O content in the range of 2 to 3% only. Scout boreholes (RKS-7 & 8) were drilled in sandstone of Taragarh Fort Formation, up to depth of 30 m. Maihar Formation in the study area is represented by brick red sandstone. Occurrence of thin band of glauconitic sandstone is reported from quarry section near Karsai, Rajor and Atewa. The maximum K₂O content is 0.23%, which is not encouraging.

On the basis of geological and geochemical result of samples, a total of 08 nos. of glauconitic bearing zones have been delineated. 04 nos. of zones have been delineated in Panna Formation viz, PMZ-I near Kaontipura having strike continuity of about 1.5 Km, PMZ-II: near Bapoti having strike continuity of 0.7 km, PMZ-III:

near Kodai, having strike continuity of 1.0 Km, PMZ-IV: Mahauli, having strike continuity of 1 Km. 03 nos. of glauconitic zones has been delineated in Jhiri Formation viz, JMZ-1: from Adadungar to Ramapura Ghati, having strike continuity of about 10 Km, JMZ-II: from Gothra to Grain having strike continuity of about 3.0 Km, JMZ-III: near Bajna having strike continuity of about 2.5 Km. One zone has been demarcated in Taragarh Formation i.e. TMZ-1: near Langrapura, having strike continuity of 1 km.

The resource of potash (K_2O) has been calculated on the basis of analytical results of core samples of 08 nos. scout boreholes and exposed length of glauconitic shale/sandstone. A resource has been calculated by cross section method, assuming 4.5% cut off grade of K_2O . Reconnaissance resource of K_2O is 57.45 Million tones with average grade of 5.30% K_2O , which is encouraging.

The demarcation of appreciable zones of potash bearing glauconitic rocks, first time in Sapotar-Karauli sub-basin of Vindhyan Supergroup, open a new vista for further investigation of potash bearing glauconitic shale/sandstone in rocks of Vindhyan Supergroup. On the basis of investigation, areas have been delineated for further G3 stage of potash exploration and new area has been recommended for G4 stage of potash exploration.

CHAPTER-2 INTRODUCTION

2.1 General Introduction

An investigation for the search of potash in glauconitic sandstone/shale of Sapotra-Karauli sub-basin of Vindhyan Supergroup was carried out, in pursuance of field season program of 2015-16, item-56, of GSI, WR. Investigation has been taken up with an objective to search and delineate glauconitic litho units in Sapotra-Karauli sub-basin of Vindhyan Supergroup. An aerial photo interpretation map of 400 Sq.km area on 1:50,000 scale has been prepared. Reconnaissance traverses were taken up to check and modified the geological contacts and structure mapped by aerial photo interpretation. Litho samples were collected to visualize potash content of glauconitic shale and sandstone. On the basis of reconnaissance traverses and potash content of litho samples, an area of about 150 Sq.km. has been delineated for large scale mapping. A total of 403 nos. of litho samples and 80 nos. of pitting/trenching samples were collected and get analyzed. The litho samples were collected from different litho units, to analyze their potash content and also to know spatial distribution of potash. A total of 300 m scout drilling has been carried out and 09 nos. of scout boreholes in order to check strike continuity and depth persistence of the glauconitic shale and sandstone delineated and recorded in the large scale mapping. A total of 255 nos. of core samples were analyzed. Petrographical studies of 37 nos. of rock samples were carried out. XRD analysis of 05 nos. of rocks/minerals samples were carried out.

Details of basis of taking of investigation

As potash is one of the prime constituent for manufacture of fertilizer along with Nitrogen and Phosphorus. The major parts of bedded marine evoprite deposit of potash are owned by Canada, Russia, Germany, Belarus, Brazil, China, and USA. Total resources of potash in India are 21816 million tons, out of that major part is owned by Rajasthan. Polyhalite, syloite, glauconite and sylvite are the major sources of potash in India. Glauconite deposit can be used as an alternative indigenous resource for potash. Glauconitic sand containing more than 5% can be

used directly, as it enhance the fertility of soil and improve soil texture also. Glauconite is also used for sugar refining, distillation of alcoholic beverages and textile industries.

India is an agrarian's country; about 98% potash is being imported to fulfil the requirement of potash. The huge revenue is being invested for potash import. To cop up the future requirement of fertilizer in view of food security, the Minister of Mines, Govt. of India, given prime importance for exploration of fertilizer minerals in addition with other minerals. In view of this, assignment has been formulated on the basis of information regarding occurrences of glauconitic sandstone/shale in rocks of Vindhyan Supergroup of Sawai Madhopur and Karauli districts, Rajasthan. The occurrence of glauconitic sandstone and shale is reported at few locations by Maharaja Singh and Sinha (1976) and Sahu (1994). Prior to formulation of this assignment reconnaissance traverses were taken in Karauli and Sawai Madhopur areas to ascertain the feasibility of the investigation.

Table -1: Nature and quantum of work carried out under item no.56, FS: 2015-16

Na	ture of work	Total Work load Envisaged	Work proposed for FS:2015-16	Total target achieved		
1.	Aerial Reco. (PGRS) 1:50,000 scale (sq km)	400 (sq km)	400	400		
2.	Geological Survey: LSM on 1:12500 scale (sq km)	150 (sq km)	150	150		
3.	Technological:					
	A. Surface Exploration					
	PT (Cu m)	80 (Cu m)	80 (Cu m)	80 (Cu m)		
	PTS (nos.)	80 nos.	80	80		
	BRS (Groove/Chip) (nos.)	320 nos.	320	324		
	B. Sub-surface Exploration					
	Drilling (Outsourced) (Scout) (m)	300 m.	300	300		
	CS (Nos.)	200 nos.	200	255		
4.	Petrographic / Mineralogical studies					
	PS	20 nos.	20	37		
	XRD#	5 nos.	5	05		
5.	Chemical Analysis (SMPL)* SiO ₂ , K ₂ O, P ₂ O ₅ , CaO, MgO, MnO, TiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ ,	600 nos.	600	659		

Table-2: Details of field stay of the officers

Name of Officer	Total nos. of field days
Mukesh Kumar Mandal, Geologist	144
2. Joy. S, Geologist*	56
3. Subhas Yadav, (Supervisory Officer)	12

^{*} As per approved field season programme 2015-16, associated officer for this investigation, Shri Sunil Kumar, Geologist, not initiated the field work under this assignment. To complete the assigned targets, Shri Joy. S, Geologist, has been posted in this item (Office Order No.237/25/TC-I/TP/WR/10; Dated 25.02.16).

2.2 Acknowledgment

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CHAPTER-3

PROPERTY DESCRIPTION

3.1 Title of ownership: Geological Survey of India, Western Region, Jaipur

3.2 Details of the area

An area of about 400 sq.km area in parts of toposheets 54B/11, 12, 15, covering parts of Sawai Madhopur and Karauli districts has been carried by photogeological studies followed by reconnatory traverses. The rhomb shaped area is bounded by coordinate A - 26°26′00": 76°50′57", B- 26°26′00": 76°57′57", C- 26°07′30": 76°37′38" and D- 26°07′30": 76°30′00" and is extending from Shyampura and Dungri in southwest to Mahauli and Mandwara in northeast, over a strike length of 48 km with average width of 10 km.

Out of 400 sq.km area, an area of about 150 sq.km is potential for glauconite hosted potash in shale and sandstone of rocks of Vindhyan Supergroup is delineated for Large Scale Mapping in 1:12,500 scale on the basis of analytical results of bed rock samples collected during orientation survey. This area extends from Sapotra in SW to Mahauli in NE, over a strike length of 26 km and width 8 km., lies in Karauli district of Rajasthan State. The LSM area is covering parts of toposheet no 54B/11 & 15 and bounded by coordinate A -26°26'00" :76°50'57", B- 26°26'00" : 76°57'57", C- 26°15'00" : 76°47'30" and D- 26°17'30" : 76°42' 30".

Cadastral details indicate that study area comprising forest land, agricultural land, water body, open scrub/grass land and built-up land. The study area is lies about 10 km north of Ranthombar Tiger Reserve and southern part of study area around Bhuri Pahari marked as buffer Tiger Zone. The forest areas contribute about 60% of the study area and occupied mostly in hilly and rocky area. The type of forest is protected forest and marked as Sapotra Protected Forest, Bapoti Protected Forest, Amarwar Protected Forest, Grain Protected Forest and Kotah Protected Forest. About 30% area is under agriculture activity and comes under private land. Approximately 6% area is occupied by water bodies mainly by ephimeral river, reservoir and ponds. About 4% area is under open scrub/grass land.

3.3 Location and Accessibility

The mapping area located between Sapotra in SW to Mahauli in NE, over a strike length of 18 km and comes under jurisdiction of Sapotra and Karauli tehsils of Karauli

district. The tehsil headquarter Sapotra is located at about 180 km southeast of state capital Jaipur and well connected by NH-11B. The area is also connected by West Central Railway Main Line. The nearest railway station is Narayanpur Tatwara, which is about 10 km west of Sapotra. The area is well connected by metalled road and providing good deal of transportation. The interior villages are also approachable through a network of metalled, semi-metalled and Kuchcha jeepable roads.

3.4 Physiography and Climate

The area is characterized by mature topography with flat low lying hills reduced to its penultimate stage of denudation. The tectonic activities and differential weathering has carved the topography in series of hills and valley, which is parallel to general strike of rocks. Valley area is mostly occupied by shale and limestone, while hilly area is marked by Tirohan breccia and sandstone of Indergarh and Taragarh Formations. The maximum elevation is 402 m amsl near Gothra village and general elevation is about 280 m with regional slope towards SW. The major river drain in the area is Kansil Nala, which is ephemeral in nature and flowing towards southwest. The area is also drained by numerous ephemeral streamlets and these streamlets are joined by several small nalas. The climate of the area is semi-arid with maximum temperature in summer rising up to 41° - 48° C and minimum temperature around 2° - 4° in winter. Severe dust storms are frequent during summer months. Average rainfall is about 60 cm per annum.

3.5 Flora and Fauna

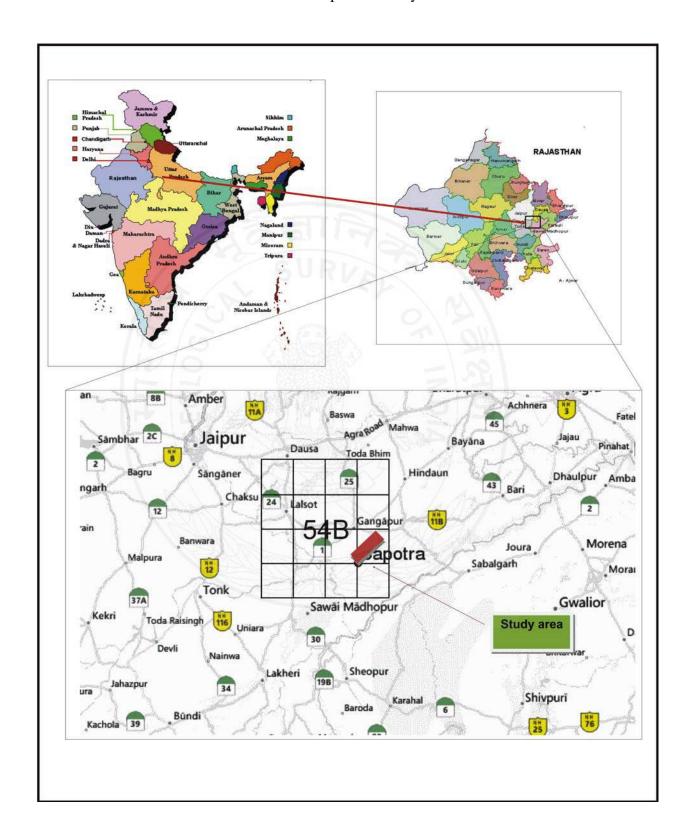
The major part of the study area is under forest cover and having hill -valley topography that gives ideal situation to flourish flora and fauna of the area. The hill slopes and the valleys support only sparse growth of vegetation in the form of thorny bushes and shrubs. Some of the area under protected forest having dense forest. The main flora includes Dhak (Anogeissus ponoula), Kher (Acacia-catechu)/ Babul (Acacia arabica) Bor (Zizivjhus jujuba), Mango (Manganifera indica), Pipal (Pious religiosa), Banyan (Ficus bengalensis). The main crops consist of wheat, bajra, maize, mustard and pulses. Wild animals reported in the area are foxes, jackal and rabbit, neelgai and chital. Variety of snakes, wild lizard, scorpion and birds i.e. peacock, Indian bustard, dove, maina, pigeon and parrot have been noticed.

3.6 Infrastructure and Environment

The infrastructures comprises basic amenity like road, rail, electricity, hospital, school, marketing center, drinking and irrigation facilities. The study area lies in part of Sapotra and Karauli tehsils of Karauli district. The maximum part of the area is under rugged topography and only about 30% area is under agriculture activity, though agriculture is main occupation of resident of the area. There are hardly any industries which can accelerate the pace of development, except few open cast mines of silica sand and clay. The condition of internal road is good. Most of the villages are facilitated with power supply. Requirement of drinking water is fulfilled by tube wells and hand pumps. Irrigation facility is available in limited area near Sapotra and Mahauli, while majority of the area is irrigated by groundwater. In general groundwater quality is suitable for both drinking and irrigation purposes.

Study area comprises historic sites like Sapotra fort & Ramotara Fort, both are situated at hill near Sapotra. The Kaila Devi temple is located in the area and is famous for hindu worship.

Plate- 1: Location Map of the study area



CHAPTER-4

PREVIOUS EXPLORATION

4.1 Details of Previous Exploration/Investigation

The geological studies has been carried out by many workers, but the exploration studies for the search of potash in the rocks of Karauli-Sapotra sub-basin of Vindhyan Supergroup of rocks, so far not conducted in the study area by Geological Survey of India. The present exploratory work is an effort for the potentialities of potash in rocks of Karauli-Sapotra sub-basin of Vindhyan Supergroup.

The rocks of Vindhyan always fascinated geoscientist for their huge thickness, aerial extend and for the exploration of natural resources. The Vindhyan rocks of Mesoproterozoic to Neoproterozoic age occupied in central part of India and covering in parts of Rajasthan, Madhya Pradesh, Uttar Pradesh and Andhra Pradesh. A group of workers have studied the various facts of the Vindhyan basin since 19th century.

As far as study area concern, Maharaja Singh and Sinha (1976) carried out systematic geological mapping on aerial photos (1:60,000 scale) of Guneshri – Sapotra- Gangapur-Kaila Devi areas of Sawai Mahopur district, Rajasthan, in parts of toposheet nos. 54B/11, 14 & 15. In this area the rocks of Vindhyan Supergroup is separated from main Vindhyan basin along a tectonized contact and lies in Sapotra-Karauli sub-basin.

Prior to present study no mineral exploration work was carried out in Sapotra-Karauli sub-basin area by Geological Survey of India. The outcomes of previous geological mapping indicate the occurrences of glauconite in the study area but it has not been explored for potash content in glauconitic rocks. Maharaja Singh and Sinha (1976), reported the occurrences of glauconitic sandstone and shale around Alampura, Bariya and Thulwari villages. The olive-green shale of Panna and Jhiri Formations is also glauconitic at places especially near Bapoti and Mahauli villages.

The occurrences of limestone, silica sand, kaolinite and laterite have been reported from the study area. Tirohan limestone was quarried at local level for making lime near Kala Devi and Mahauli. Mining of silica sand is continuing at many places from friable sandstone of Taragarh Formation. An abandoned quarry of laterite has been reported from sandstone of Taragarh Formation from Bajana area. The brick red

spotted Maihar sandstone is prime source for building and decorative stone and begin quarried at several locality at large scale.

4.2 Details of aero-geophysical and geophysical mapping

The study area is not covered under aero-geophysical mapping; however under National Geophysical Mapping programme (NGPM), gravity and magnetic surveys are done in toposheet 54B/11 & 15, during the field season programme 2015-16.



CHAPTER-5

GEOSCIENCE INVESTIGATION

5.A. Regional Geology

5.A.1 Aerial Reconnaissance Study

Aerial reconnaissance survey was carried out of 400 Sq. km area, using aerial photos on 1:50,000 scale. On the basis of tone and textural difference, different litho units were demarcated, which helped to understand the rock types, outcrop pattern and structural elements of the study area. Reconnaissance traverses were taken to check the geological contacts and structure mapped by aerial photo interpretation. About 50% area is occupied by rocky land and 50% area is concealed under Quaternary Sediments. Area comprises an alternate sequence of soft and moderately hard rocks, forming a series of hills and valleys (Plate-2) & (Figure-1). Structural features like fault and lineaments were also demarcated.

I. Hill/ridge

The north-eastern part of the area is occupied by moderately resistance rocks where hills/ridges from Gothra to Mahauli are present. Hills are made up of sandstone of Taragarh Formation which attains maximum elevation in the area. Other ridges belongs to sandstone of Indargarh Formation. Another area is lying in southern part around Bhuripahari comprises quartzite of Bhilwara Supergroup.

II. Isolated mound

Isolated mound of Tirohan Breccia is present west of Sapotra and east of Kaila Devi.

III. Plateau area

Area laying in eastern margin of southern part, around Khoh forming a flat top hill/plateau and bounded by escarpment, it belong to sandstone of Maihar sandstone.

IV. Valley area

There are alternate sequence of hill and valley. All valley portion is occupied by softer rocks i.e. shale of Panna and Jhiri Formations. All along the foot hill on eastern and western limbs of syncline, isolated outcrops of olive green, gray and maroon shale has

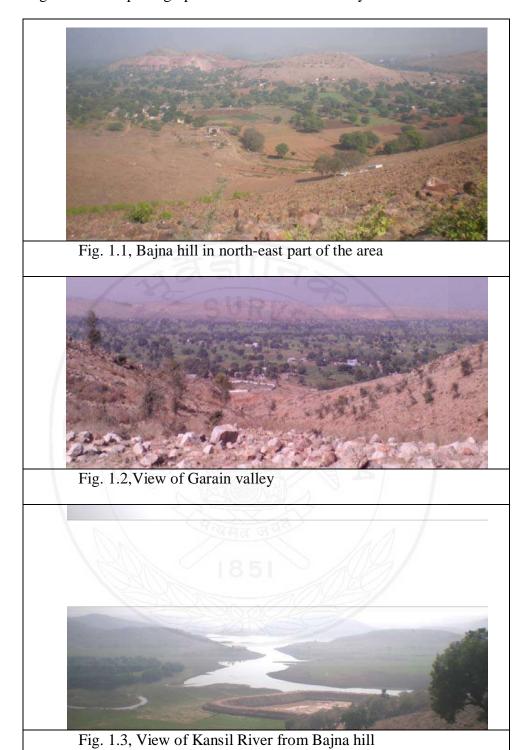
been observed. At most of places it is covered by scree or alluvium, which make difficult to mark boundary between shale and sandstone.

V. Alluvial plain

About 30% area is marked as alluvial plain, especially along western margin and core of the syncline structure. It consists of sand, silt and clay. The study area falls in the catchment of Banas River, this is ephemeral in nature and flowing south-easterly in southern part of the study area.



Figure-1: Field photograph of landforms of the study area



5.A.2 Brief Regional Geology

Regional geology of the study area is manifested by the rocks of Bhilwara Supergroup and the rocks of Vindhyan Supergroup (Plate-3). In the area Bhilwara Supergroup is represented by Ranthambhor Group (Lower Proterozoic). The rocks of Ranthambhor Group comprise Hora and Bari Sadri Formation; it consists of quartzite, phyllite, slate, schist and basic rock. The rocks of Ranthambhor Group lies in western and north-western part of study area, while rocks of Vindhyan Supergroup lies in eastern and southern part of study area. These are having tectonic contact in the form of NE-SW trending Great Boundary Fault (GBF) (Heron, 1917). The Vindhyan basin represents one of the most spectacular Proterozoic basins developed in the shadow of the Bundelkhand Granite Massif, Aravalli-Delhi and the Satpura orogenic belts. It comprises undeformed and unmetamorphosed sediments, resting unconformably on the eroded surfaces of the Archaean and Early Proterozoic rocks. The rocks of Lower Vindhyan are predominantly calcareous while the Upper Vindhyan is predominantly arenaceous although both formed a conformable sequence. The Vindhyan Supergroup comprises a variable proportion of conglomerates, breccias, sandstones, shale and limestone with a total thickness of 3200 to 4300 m.

The western part of Vindhyan basin occurs in south-eastern part of Rajasthan and occupies an area of about 20,000 Sq. km, constituting roughly one fourth area of the total expanse of the Vindhyan basin. In Rajasthan, Vindhyan sequence is developed in two areas within two sub-basin, namely, Chittaurgarh –Mandsaur area (Chittaurgarh sub-basin) in the southwest and Sawai Madhopur-Sapotra-Karauli-Dholpur area (Sapotra-Karauli sub-basin) in the northeast. The present study area lies in Sapotra-Karauli sub-basin, which is separated from main Vindhyan basin along a tectonized contact, Maharaja Singh and Sinha (1976).

The area experienced two phase of deformations. Developments of deformational structures are well evident by anticline and syncline between GBF and its sympathetic faults. Present LSM area lies in Sapotra-Gunushri syncline, which is a broad symmetrical doubly plunging syncline. The general strike of rocks is NE-SW having shallow to moderate dip towards NW and SE. The primary sedimentary structures are well preserved in the form of bedding, graded bedding, cross bedding and ripple marks which reveal the geological history of the area.

RAJASTHAN Scale Sawai Madhopur Phalodi Ramgarh Shahb 25° -Chittorga Source: Ramasamy, 1995 INDEX Deccan Traps Study area, FS:2015-16 Bhander Group Rewa Group Great Boundary Fault Kaimur Group Semri Group Bundelkhand Granite

Plate: 3, Regional geological map of Vindhyan Basin, Rajasthan

5.A.3 Regional stratigraphy

Oldham (1848) first proposed the name Vindhyan. Heron, (1917) mapped this area under Vindhyan System and brought to light the details of both Lower and Upper Vindhyan rocks. Two-fold classification of the Vindhyan Supergroup i.e. Lower and Upper, it comprising the Semri Series and the latter includes the Kaimur, Rewa and the Bhander Series. Sinha (1975) maintained the classification put forth by Heron but replaced the terms System and Series by Group and Formation respectively in conformity with the code of stratigraphic nomenclature of India. In Sawai Madhopur-Sapotra- Karauli area, the work of Dutta, Singh and Sinha (1974-1977) brought to light the details of lithostratigraphy and primary features and their bearing on the sedimentation, paleogeography and tectonics of the basin. Sahu (1988-90) carried out compilation of the Vindhyan Supergroup and grouped the rock formation of this area under the Ranthambhor Group and Vindhyan Supergroup. Maharaja Singh and Sinha, (1976) carried out systematic geological mapping on aerial photographs (1:60,000 scale) of Guneshri-Sapotra-Gangapur-Kaila Devi areas, parts of Sawai Mahopur district, Rajasthan. Regional lithostratigarphy of Sapotra-Karauli area is shown in table-3.

The rocks of Ranthambhor Group (Lower Proterozoic) comprises Hora and Bari Sadri Formation. The rocks of Vindhyan Supergroup overlie the eroded surfaces of the Archaean and Early Proterozoic rocks. It comprises alternate sequences of sandstone and shale with limestone intercalation. There are exposures of complete sequences of Vindhyan Supergroup in the study area. Lower Vindhyan is represented by the rocks of Semri Group, it comprises Tirohan Conglomerate, Tirohan Limestone and Tirohan Breccia Formations. Tirohan Conglomerate is oldest unit exposed adjacent to south-western boundary of the study area. Tirohan Limestone occurs as isolated outcrop along the eastern flank of syncline and at palces algal in nature. The Tirohan Limestone is overlain by Tirohan Breccia which occurs as linear ridge on eastern and western flank of syncline.

The rocks of upper Vindhyan are represented by Kaimur, Rewa and Bhander Groups. The overlying Kaimur Group is represented by sandstone unit with conglomerate bed, which indicate the beginning of upper Vindhyan. Rewa Group is represented by Panna Shale, Indargarh, Jhiri Shale and Taragarh Fort Formations. It

comprises alternate sequences of sandstone and shale with occasional limestone. The glauconitic shale and sandstone is reported from Panna, Jhiri and Taragarh Formation during the present study. The Bhander Group is represented by Sirbu and Maihar Formations and is present mostly in southern part of the study area. Sirbu shale is purple, friable and distinctly laminated. Maihar sandstone form a plateau in southern part of the study area which attain the highest level. The Maihar sandstone is purple to brick red with white spots and streak. The Quaternary sediment covers north-western part and consists of fluvial and aeolian sediments.



Table- 3: Regional stratigraphy of Sapotra-Karauli sub-basin (Maharaja Singh & Sinha, 1976)

Supergroup	Group	Formation	Litholgy	Age	
		Quaternary (unclassified)	Fine sand, silt and clay	Quaternary	
	Bhander	Maihar (Upper Bhander Sandstone)	Massive sandstone, Sandstone with intercalated shale	Neoproterozoic	
		Sirbu	Shale with limestone bands, Limestone		
	/3	Taragarh Fort (Upper Rewa Sandstone)	Sandstone		
	Dayya	Jhiri	Shale with limestone	Mesoproterozoic	
Vindhyan		Indargarh (Lower Rewa Sandstone)	Sandstone	Neoproterozoic Mesoproterozoic	
Supergroup		Panna	Shale		
		Chittoragarh Fort	Sandstone with pebbles and Conglomerate at base		
	1	Tirohan Breccia	Brecciated ferruginous quartzite and porcellanite		
	Semri	Tirohan Limestone	Stromatolitic cherty limestone		
		Tirohan Conglomerate	Conglomerate with grit, sandstone and shale		
Intrusive			Dolerite/ meta-dolerite		
Bhilwara	Ranthambhor	Bari Sadri	Phyllite, Quartzite with slate/phyllite/schist	Palaeoproterozoic	
		Hora	Quartzite		

5.B. Detailed Geological Exploration

5.B.1 Large Scale Mapping (1:12,500) scale

On the basis of reconnaissance survey along with random sampling and outcrop pattern, an area of about 150 Sq km has been selected for Large Scale 23

Mapping. Large Scale Mapping were carried out of 150 Sq. km area on 1:12,500 scale in Sapotra-Mahauli area of Sapotra-Karauli sub basin of Vindhyan Supergroup (Plate- 4). It extends from Sapotra in SW to Mahauli in NE over a strike length of 20 km, in NE-SW trend. Survey of India toposheet was used as base map for mapping and mapping has been carried out with the help of GPS, tape and Brunton. As per objective of the assignment emphasis was to delineate the glauconitic litho units of the rocks of Vindhayn Supergroup, in parts of Sapotra-Karauli sub-basin.

5.B.2 Description of Rock types

5. B.2.1 Vindhyan Supergroup

The Large Scale Mapping reveal the presence of litho assemblages of both the Lower and Upper Vindhyan sequences of Mesoproterozoic to Neoproterozoic age and Quaternary sediments. Vindhyan sequences comprise alternate sequences of sandstone and shale with occasional limestone. The deformation and differential weathering of the rocks of the mapping area gave rise to highly undulating topography. In the mapping area the oldest Semri Group is represented by Tirohan Limestone and Tirohan Breccia, while basal conglomerate of Tirohan Conglomerate Formation is not present. The overlying Kaimur Group is marked by basal part of Upper Vindhyan sequence and is represented by Chittoragarh Fort Formation. The overlying Rewa Group is represented by Panna, Indargarh, Jhiri and Taragarh Formations. The youngest Bhander Group is represented by Maihar Formation, exposure of Sirbu shale is not present in the study area. Based on the field observations and structural study of the mapped area, the stratigraphy of the Sapotra-Karauli area is given in Table-3. The field photographs of different rock type of the mapping area are shown in figure-2.1 to 2.18.

Table-4: Stratigarphy of Large Scale Mapping area.

Group		Formation	Lithology	Age
		Quaternary (unclassified)	Fine sand, silt and clay	Quaternary
	Bhander	Maihar (Upper Bhander Sandstone)	Massive sandstone, Sandstone with intercalated shale,	Neoproterozoic
Upper		Taragarh Fort (Upper Rewa Sandstone)	Sandstone	Mesoproterozoic to Neoproterozoic
Vindhyan	Darria	Jhiri	Shale, limestone	
	Rewa	Indargarh (Lower Rewa Sandstone)	Sandstone	
		Panna	Shale	
	Kaimur	Chittoragarh Fort	Sandstone with pebbles and conglomerate at base	Mesoproterozoic
	19E/	Tirohan Breccia	Brecciated ferruginous quartzite and porcellanite	
Lower Vindhyan	Semri	Tirohan Limestone	Stromatolitic cherty limestone	
		Tirohan Conglomerate	Conglomerate with grit, sandstone and shale	

Bhilwara Supergroup

5.B.2.1.1 Semri Group

The rocks of Semri Group occupy the major part of mapping area and lying on eastern and western flank of syncline. The oldest formation i.e. Tirohan Conglomerate is not exposed in the study area.

5.B.2.1.1.1 Tirohan Limestone Formation

Tirohan Limestone is underlain by Tirohan Conglomerate Formation. Limestone is steel grey to creamy yellow, at places flesh red in colour and is fine grained. It is a very impure variety of limestone with varying proportion of silica content and at places it is stromatolitic also. It occurs as isolated outcrops mostly along the eastern flanks of the syncline near Mahauli, south west of Kaila Devi, west of Sapotra and Tursangpura. At these locations, there is evidence of mining of the limestone mainly for lime manufacture. Presently area is not under mining activities.

The rock follow the general strike of the area i.e. NE-SW having gentle dip towards NW on eastern flank of syncline. The maximum exposed thickness of limestone is about 30 m, as seen around south-west of Kaila Devi. Litho sample (S-40) show maximum concentration of CaO i.e. 36.90%. A band of glauconitic sandstone is reported from lower part of Tirohan limestone, near Mahauli. The sandstone is olive-green and coarse to medium grained in nature. It is 1.35 m thick and traced over a strike length of 2 km. The band is detached, fractured and mostly covered with scree material of overlying limestone and breccias on scarp face. The bed rock samples (M-441, 446 & 447) show very low concentration of K_2O (0.01 to 0.04%). Field photographs of different litho units of Tirohan Limestone Formation are shown in figures- (2.1 to 2.3).

5. B.2.1.1.2 Tirohan Breccia Formation

Tirohan Breccia Formation occupied maximum spatial distribution and forming prominent ridge. It is underlain by Tirohan Limestone and contact is obscured by the breccia scree. Tirohan breccia is composed of sharp angular fragments of chert, agate, jasper in cryptocrystalline siliceous matrix, which is white, yellow, pale brown and yellowish green. Size of fragments ranges from a millimetre to a meter. In the study area breccia is without stratification and highly deformed. The clay pocket is reported from few places near Sapotra, which is used for manufacture of tiles and paint and locally known as 'khari'. Chemical analysis of a Tirohan breccia sample (S-36) contains SiO₂ (63.37%), Al₂O3 (21.64%), and K₂O (4.40%). Iron mineralization is also observed in the form of detached and fractured band of hematite and magnetite near Kahoda, west of Sapotra. Chemical analysis of bed rock sample (M-636) shows that it contain Fe₂O₃ 60.29%. Field photographs of different litho units of Tirohan Breccia Formation are shown in figures- (2.4 to 2.6).

As far as glauconite mineralization is concerned, no prominent lithounit has been observed during the present study. Light green colour chert has been observed at many places especially around Gorahar in southwest part and near Mahauli in northeast part of the study area. Chemical analysis of the chert samples (M-240,445 & 626) showed K_2O of 0.11%. The K_2O value of the chert samples ranges from 0.01% to 4.40% with an average of 0.79%.

5.B.2.1.2 Kaimur Group

5.B.2.1.2.1 Chittoragarh Fort Formation

It marks the beginning of Upper Vindhyan. A distinct unconformity is marked by the conglomerate horizon at the base of the Kaimur Group, which separates the Lower and Upper Vindhyan rocks. In general the conglomerate consists of well sorted, rounded quartz grains with fragments of red, brown or black jaspar and black or white cherts, embodied in a siliceous matrix. The conglomerate shows gradational variation from conglomerate to fine grained sandstone. The basal pebbly to conglomeratic horizon is succeeded upward by coarse and fine grained sandstone embedded with occasional pebbles. The rock occurs as isolated outcrops and is exposed near Mahauli, Suratpura, Nishana, Amargarh and Kodai. Graded bedding is a typical feature which is observed near Nishana in south-western part of the study area. The primary sedimentary structures like ripple marks and current biddings are well preserved. Field photographs of different litho units of Chittoragarh Fort Formation are shown in figure- 2.7.

The lithounits of Chittoragarh Fort Formation do not show indication of glauconite mineralization.

5.B.2.1.3 Rewa Group

The rocks of Rewa Group occupied maximum part of the study area and it comprises alternate sequence of sandstone and shale with occasional limestone.

5.B.2.1.3.1 Panna Formation:

Panna Formation is underlain by Kaimur Group of rocks and is overlain by Indargarh sandstone. The lower contact is mostly covered by alluvium and upper contact is mostly covered with scree of Indargarh sandstone. The shale is greenish to olive green, gray and maroon in colour. It is well laminated, fairly indurated and shows frequent intercalations with thin bands of sandstone varying in thickness from 2 cm to 50 cm. However, the shale has a much higher predominance over sandstone and their ratio is about 8:2. Topographically, the Panna shale occupied mostly valley area and scarp side of Indargarh sandstone. Shale occurs as isolated patches mostly in the eastern part of syncline, while in western side it is concealed under alluvium. Outcrops have been observed around Sapotra, Kaontipura and Bapoti in southwest part and around Mahauli

and Bajne ka Pura in northeast part of the study area. It has the best development around Mahauli, with a maximum thickness of around 48 meters.

During the present study, it has been observed that olive green Panna shale contain glauconite in various proportions from 30 to more than 90% of its total mineral content. The thickness of olive green shale, maroon and pale yellow shale varies from place to place. At places Panna shale is intercalated with thin bands of medium to coarse grained glauconitic sandstone, especially near Kaontipura (Quarry section). Chemical analysis of 76 nos. of bed rock samples of Panna Shale indicates that light green to yellow shale contain maximum K₂O content up to 7.21% (sample P-36). The K₂O of the bed rock samples range from 0.76% to 7.21% with average value of 5.08%. Out of 76 samples, 51 nos. of samples shows K₂O content more than 5%, which is encouraging. Scout boreholes (RKS-4 & 6) were drilled in Panna shale to know the depth persistence of glauconitic shale at Kaontipura and Bapoti in southwestern part of the study area. It indicates that olive-grey to light green shale is continuing up to depth of 30 m. In core samples of boreholes RKS-4 & 6, the average K₂O content is 5.2 and 4.75 % respectively. Field photographs of different litho units of Panna Formation are shown in figure- (2.8 to 2.9).

On the basis of mapping and analytical result of bed rock samples four glauconite bearing zones have been delineated in rocks of Panna Formation, i.e. PMZ-I near Kaontipura, PMZ-II near Bapoti, PMZ-III near Kodai and PMZ-IV near Mahauli.

5.B.2.1.3.2 Indargarh Formation (Lower Rewa Sandstone):

The rocks of Indargarh Formation have gradational contact with underlying and overlying rocks of Panna and Jhiri Formations respectively. In the study area Indergarh Formation is represented mainly by sandstone, while at places parting of shale is also reported. Sandstone is fine to medium grained, white to grey in colour, very compact and quartzitic in nature. It comprises more than 90% of quartz which is mostly sub-rounded to rounded. It occurs as linear ridge on both the eastern and western limb of syncline structure and occupying a vast span of area. The maximum exposed thickness is about 90 m near Bapoti. The primary sedimentary structures including bedding, cross bedding and ripple marks (both symmetrical and symmetrical types) are well preserved. Field photographs of different litho units of Indargarh Formation are shown in figure (2.10 to 2.11). Crushed rock of Indergarh Formation near Kaontipura and Bapoti is presently

mined as clay mineral (Khari). The analytical result of these samples (S-23, S-42, M-234 & M-245), shows that it contain SiO_2 (58.03%), Al_2O_3 (23.05 %) and K_2O (2 to 5.65%).

There is no indication of glauconite mineralization in the sandstone of Indargarh Formation in the study area.

5.B.2.1.3.3 Jhiri Formation

The rocks of Jhiri Formation have gradational contact with underlying and overlying rocks of Indargarh and Taragarh **Formations** respectively. Geomorphologically, the rocks of Jhiri Formation occurs in valley portion and scarp side of sandstone of Taragarh Formation. In valley portion, it is mostly concealed under alluvium and on scarp side it is covered with scree material, so both upper and lower contact are not comprehensible. In the study area Jhiri Formation is represented mainly by shale with minor intercalation of siltstone, sandstone and limestone at places. Glauconitic sandstone/siltstone is also associated with shale at places. The Jhiri shale is pale yellow or khaki, olive green, reddish brown or purple, soft and fissile, thinly bedded to laminated and splintery in nature. In general the shale is very fissile and with the touch of hammer crumble into pieces. The best exposure is observed around Kotas and Mach, which is about 3 km northeast of the study area. The maroon colored highly jointed typical Jhiri shale is overlain by thin bands of olive green shale horizon. The olive green shale is intercalated with sandstone and gradually merges with the Taragarh sandstone. The depth persistence and strike continuity of olive shale is not consistent.

In the study area Jhiri shale is exposed as isolated patches mostly on eastern limb of syncline, while on western limb it is mostly concealed under alluvium and scree material. It is exposed near Gothra and Garain on western limb of syncline, while on eastern limb it is having isolated outcrop over a strike length of more than 10 km from Adadungar to north of Ramapura. A limestone horizon is exposed between Bajna and Adadungar area, which is fine grained, grey to light purple in color, non-stromatolitic, compact and impure in nature, it lies below the maroon splintery shale. Field photographs of different litho units of Jhiri Formation are shown in figures-(2.12 to 2.13).

Olive green shale is most potential litho unit for potash content, it contain glauconite ranging from 60% to 90% of total mineral content. The depth persistence

and strike continuity is not uniform. To ascertain the depth persistence and strike continuity of olive green shale, 05 nos. of shallow scout boreholes RKS-1, 2, 3, 5 & 9 were drilled, up to maximum depth of 45m. The scout boreholes RKS-5 & 9 were drilled on western limb and RKS-1, 2, & 3 were drilled on eastern limb of syncline structure. It is observed that maximum thickness of olive green shale is observed in RKS-05 near Gothra on western limb, where it is continuing up to depth of 45 m.

Chemical analysis of 193 nos. of litho samples indicates that olive green to light green shale contain K_2O concentration ranging from 0.63% to 6.64% (sample JS-80), with an average value of 4.50%. Out of 193 samples the K_2O concentration of 62 nos. of samples are having more than 5% encouraging values.

Glauconitic sandstone/siltstone is delineated in Jhiri shale, which is first of its kind in this study area. The thickness of glauconitic sandstone/siltstone varies from 2 cm to 1 m and mostly in weathered condition. In the mapping area glauconitic sandstone/siltstone is observed around Ramapura and Bhatpura.

On the basis of mapping and sampling, three potential areas have been delineated in Jhiri Formation, i.e. JMZ-1 Adadungar to Ramapura Ghati, JMZ-II Gothra to Grain and JMZ-III near Bajna.

5.B.2.1.3.4 Taragarh Fort Formation (Upper Rewa Sandstone)

The rocks of Taragarh Fort Formation have gradational contact with underlying Jhiri Formation. It comprises mainly sandstone with occasional intercalation of siltstone and shale. In the study area it occupies in the core of syncline structure. Geomorphologically, it forms high linear ridge and saddle landform especially from Adadungar to Ramapura on eastern limb. Sandstone is fine to medium grained, white to buff and pale grey in colour and is made up of quartz (more than 90%) with subordinate amount of feldspar, tourmaline, magnetite, biotite and at places glauconite. The sandstone is moderately to well sorted and comprises sub angular to sub rounded grains of quartz, it is compact and highly jointed. Four sets of joints are recognized, along the joint and fracture planes limonite coatings are common. Jointing is regular and it gives rise to cubical and rectangular blocks, by weathering and erosion these blocks are often transformed into spherical shape, especially in the upper part of formation. Primary sedimentary structures are in abundance in the form of bedding, cross bedding and ripple marks (both symmetrical and asymmetrical type).

The maximum thickness of the formations is observed near Bajna, Adadungar and Gothra area, where exposed thickness is about 95 m. A laterite horizon has been observed on Bajana hill top, which spread over a length of 200 m along strike continuity. The laterite shows pisolitic structure and was earlier quarried for making paints and pigments. A localized pocket of friable sandstone is observed at many places along western and eastern flank of Taragarh sandstone. It is mined for silica sand; the colour of silica sand varies from milky white to light yellowish brown and used in glass industries. The opencast mining of silica sand is carried out near Mijhaura, Bhatpura, Bichpanya, Ramapura, Alampur, Barriya, Saimarda and Garain. Field photographs of different lithounits of Taragarh Fort Formation are shown in figures- (2.14 to 2.15).

During the present study glauconite mineralization is reported first time from Taragarh sandstone near Garain, Gangurda and Manoharpura. It is also observed in the dump of dug well in valley part and extends from Garain to Saimarda over a distance of 4 km along strike continuity. Glauconite is associated with medium to coarse grained sandstone; it occurs as thin lenses and disseminated at places. Thickness of glauconitic sandstone varies from 2 cm to 2 meter, maximum thickness of 2 m is observed near Manoharpura in an old pit. The concentration of glauconite varies from 10% to 30% of total mineral content. The strike continuity of glauconitic sandstone is not uniform; mostly it occurs as isolated patch or it merges with non-glauconitic sandstone. The chemical analysis of one bed rock sample (M-155) shows maximum concentration of K₂O in glauconitic sandstone i.e. 5.93%, while K₂O content of the samples ranges from 0.01 to 5.93% with an average of 3.60%. Scout boreholes (RKS-7 & 8) were drilled in sandstone of Taragarh Formation, with maximum depth of 30 m, to ascertain the depth persistence and strike continuity of glauconitic sandstone/shale. The glauconitic sandstone is reported in RKS-7 between 5 to 7 m depth.

5.B.2.1.4 Bhander Group

Bhander Group comprises youngest litho package of Vindhyan Supergroup. In Sapotra-Karauli sub-basin it is represented by Sirbu and Maihar Formations which consist of shale, limestone, massive sandstone. In the present study area the outcrop of Sirbu Formation is not observed/reported, either it is eroded or concealed under the overlying Maihar sandstone.

5.B.2.1.4.1 Maihar Formation (Upper Bhander Sandstone)

In the study area rocks of Maihar Formation is represented by Massive sandstone and sandstone with intercalated shale. The rocks of Maihar Formation is totally eroded from central part of the study area, however it occurs as isolated linear strike ridges in north-eastern part and along eastern flank of syncline, near Chhipghata, Bawali, Mahauli and Karsai. The eastern boundary of the study area has huge thickness of Maihar sandstone forming prominent land mark plateau having elevation of 423 m msl. This plateau area is separated from study area along NE-SW trending major fault.

The Maihar sandstone is characteristically brick red to purple in colour, with white spots and streaks, at places sandstone is intercalated with shale. In the study area spotted red sandstone horizon shows the maximum development in Karsai and Rajor area. The primary sedimentary structures like current bedding, ripple marks are well preserved in this horizon. Field photographs of different lithounits of Maihar Formation are shown in figures- (2.16 to 2.18).

Occurrences of glauconitic sandstone/shale are observed from quarry section near Karsai, Rajor and Atewa. The light green colour glauconitic sandstone and shale occurs as thin bands between sandstone. Glauconitic sandstone has thickness varying from a few cm to a meter. It contains mica as accessory mineral. The analytical results of 02 nos. of bed rock samples (M-577,642) shows very low K₂O concentration i.e. 0.23 and 0.02%; respectively.

5.B.2.3 Quaternary Sediments

Quaternary Sediments occupied about 30% of the study area, which comprises mainly sand, silt and clay of various proportions. The thickness of Quaternary Sediments ranges from 20 to 30 m the western margin of the study area near Hariya ka Mandir and Kanapura. The valley portion is mostly occupied by alluvial sediments; the thickness of sediments in valley area varies from 1 m to 10 m. The soil of the study area is bearing the impression of lithology of underlying rocks and its catchment. In upland area red soil is predominant, while in valley area gray colour silty soil is predominant. According to Department of Agriculture, Sapotra, Govt. Of Rajastahn, the soil of the study area contains very high potash content. The high potash content in

the soil may be contributed by weathering and erosion of glauconitic shale/sandstone of the catchment area and its deposition in the valley parts.

Figure- 2: Field photographs of lithology of the mapping area



Fig. 2.1. Brecciated Tirohan limestone near Mahauli.



Fig. 2.2. Thick band of Tirohan limestone near Khaoda.



Fig. 2.3. Glauconitic sandstone, associated with lower part of Tirohan Limestone Formation near Mahauli.



Fig. 2.4. Outcrop of Tirohan breccia near Sapotra.



Fig.2.5. Outcrop of Tirohan breccia, near Mahauli



Fig. 2.6. Brecciated iron band, near Khaoda, Tirohan breccia.



Fig. 2.7. Compositional banding, Kaimur Sandstone near Nishana,



Fig. 2.8. Splintery maroon shale intercalated with thin band of sandstone, Panna Formation, near Mahauli



Fig. 2.9. Olive shale intercalated with maroon shale, Panna Formation, near Mahauli



Fig. 2.10. Thickly bedded sandstone, Indargarh Formation, near Sapotra.



Fig. 2.11. Sandstone intercalated with shale, Indargarh Formation, near Bapoti.



Fig. 2.12. Olive shale near Bajna, Jhiri Formation.



Fig. 2.13: Impure limestone with calcite vein, near Dudrai, Jhiri Formation.



Fig. 2.14: Sandstone shale intercalation, near Alampura, Taragarh Formation.



Fig. 2.15: Thin bed of glauconitic sandstone, near Manoharpura, Taragarh Formation.

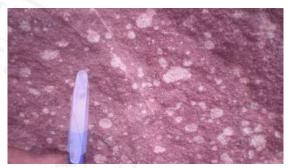


Fig. 2.16: Brick red spotted sandstone, Maihar Formation, near Rajor.



Fig. 2.17: Intercalation of glauconitic shale with sandstone, Maihar Formation near Atewa.



Fig. 2.18: Thinly laminated glauconitic layer, Maihar Formation, near Rajor.

5.B.4 Petrological and petrochemical studies

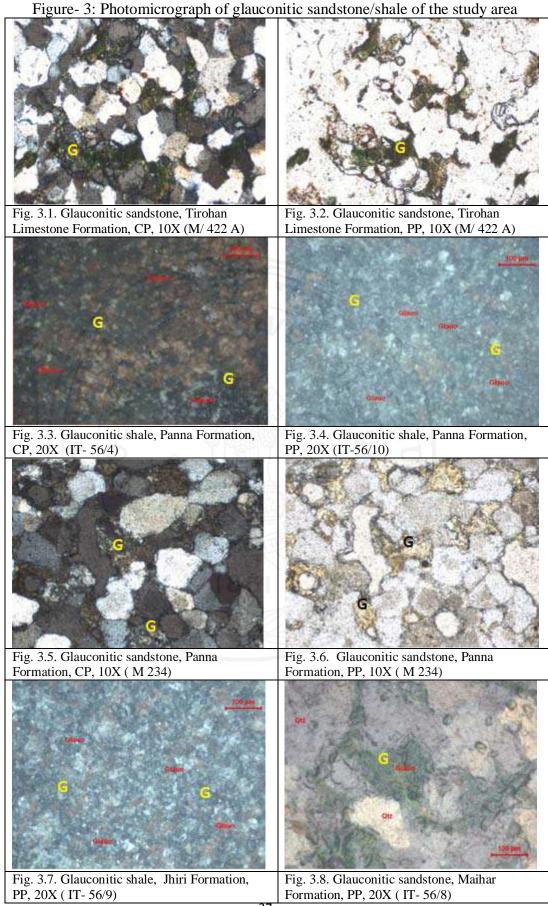
5.B.4.1 Petrographic studies

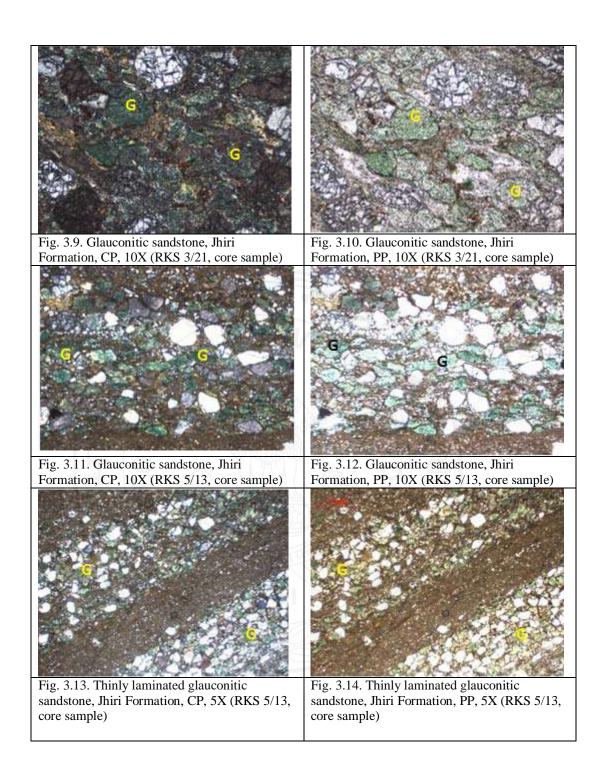
Petrographic studies of the different rocks and core samples, containing glauconite mineral were carried at Petrological Lab, GSI, WR, Jaipur.

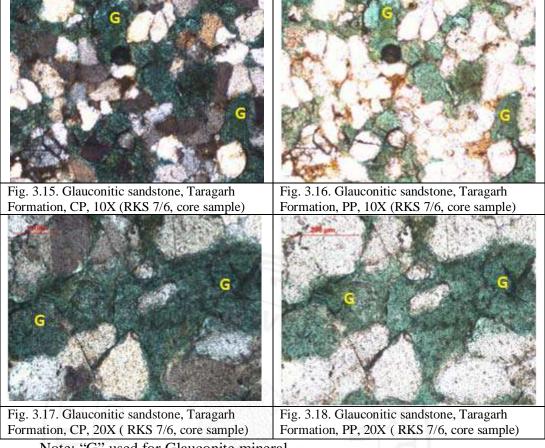
The emphasis was given to identification of glauconite mineral and its mode of occurrences, especially in the rocks of Panna, Jhiri and Taragarh Formations, which posses the indication of glauconite mineralization during field study. Petrological studies infer that glauconite mineralization is mainly associated with olive, light green and yellowish green shale of Panna and Jhiri Formations, the glauconite percentage varies in shale from 50 to 90%, mostly disseminated in nature and occurs as thin lamination. The thin band of glauconitic sandstone is also associated with Panna and Jhiri Formations. The Taragarh sandstone also has glauconite, though it occurs as thin lenses. In sandstone glauconite percentage varies from 10 to 25%. Details of thin sections are shown in table: 5. Photomicrograph of glauconitic sandstone/shale are shown in Fig.3 (3.1 to 3.18). The glauconite mineral is marked with letter "G".

Table-5: Details of petrological studies of the study area.

S. No.	Slide No.	Latitude	Longitude	Lithology
1	M/422A	26°24'57.8"	76°54'46.2"	Glauconitic sandstone, Tirohan Formation
2	TS 56/4	26°25'8.3"	76°50'30.4"	Glauconitic sandstone, Tirohan Formation
3	M/234	26°16'45.8"	76°45'12.6"	Glauconitic sandstone, Panna Formation,
4	TS 56/10	26°10'4.1"	76°34'34.3"	Glauconitic shale, Panna Formation
5	IT 56/9	26°20'17.5"	76°50'42.6"	Glauconitic shale, Jhiri Formation
6	KS 3/21	26°18'24.1"	76°48'39.5"	Glauconitic shale, Jhiri Formation
7	KS 5/13	26°19'10.8"	76°47'38.4"	Glauconitic shale, Jhiri Formation
8	KS 7/6	26°21'59.4"	76°49'44.1"	Glauconitic sandstone Taragarh Formation
9	TS 56/8	26°25'30.7"	76°57'4.2"	Glauconitic sandstone, Maihar Formation







Note: "G" used for Glauconite mineral

5.B.4.2 Petrochemical studies

Sampling is the most essential and important part in mineral exploration, commencing from the beginning of large scale geological mapping.

A total of 658 nos. of samples have been collected from the mapped area including 323 bed rock samples, 80 pit/trench samples and 255 core samples. Total of 255 nos. of core samples are prepared from core of boreholes, RKS-1, RKS-2, RKS-3, RKS-4, RKS-5, RKS-6, RKS-7, RKS-8 & RKS-9 and chemically analyzed at Chemical Division, GSI, WR, Jaipur. These 658 nos. of samples were analysed for major oxides i.e. SiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, MnO, K₂O, P₂O₅, Na2O and TiO₂.

5.B.5 Structure

The primary sedimentary structures are preserved in almost all the litho package of Vindhyan Supergroup in the study area. The evidence of primary sedimentary structures is manifested by the presence of bedding, cross bedding,

graded bedding, mud cracks, ripple marks. The evidence of organic sedimentary structures is indicated by presence of stromatolites in Tirohan limestone, at places.

Structural elements suggest that study area experienced two phase of deformation. The general strike of beds is NE-SW direction, with low to moderate dips varies from 8° to 40° towards NW and SE and forming syncline structure. Tectonic activity gives rise to development of secondary structures, which is well evident in the study area by presence of fold, fault, joints and fracture. The Great Boundary Fault (GBF) which is passing through southern part of the study area and it separates Vindhyan Supergroup from older Bhilwara Supergroup (Plate-3). The deformational structures are confined mainly between the two major NE-SW trending parallel faults which pass from eastern and western boundary of the study area. The different structures of the study area are shown in figures- (4.1 to 4.10).

(A) Primary structure

Bedding:

Bedding is mainly defined by compositional layering. Bedding and laminations are well preserved in almost all the rock types except in Tirohan Breccia. The thickness of individual sandstones beds varies from 0.5 cm. to 2.5 m. and in shale it varies from 0.1 cm. to 1 m. Maihar sandstones predominantly display horizontal to sub-horizontal dips.

Cross bedding

Cross beds are the most prominent sedimentary structures preserved by almost all the arenaceous units. They are of both tabular and trough types. The dip of the foreset varies from 15 to 35°. The study of cross beds reveals a general northerly palaeocurrent direction with little occasional fluctuation towards east or west.

Ripple marks

Ripple marks observed invariably in all the arenaceous rocks especially in Indargarh sandstone near Bapoti and in Taragarh sandstone near Garain and Gothra area. Both symmetrical and asymmetrical types are observed in the area. The wave length of ripples varies from 0.4 to 2 cm.

Mud cracks

Mud cracks indicate the sediments were exposed to surface to allow water loss and shrinkage. This might have happened under arid climatic conditions in a near shore environment of deposition. In the study area these are observed in the sandstone of Taragarh Formation.

Penecontemporaneous folding

Folding of a single layer of sandstone or shale has been observed at many places in rocks of Panna and Jhiri Formation.

Graded bedding:

Graded bedding has been seen at a number of places within Rewa and Kaimur sandstone. This is best developed in Kaimur sandstone where all gradations can be seen from gritty sandstone to a fine grained variety in a single bed near Nishana.

(B) Secondary structure:

The Vindhyan rocks of the area have been subjected to two phases of deformations. Secondary structures are present in the form of fold, fault and joints.

Fold:

Study area reflects two generation of folding. During the first phase, due to compression from NW-SE, primary set of NE-SW trending and moderately plunging syncline and anticlines developed especially in vicinity of the boundary fault i.e. Guneshri-Sapotra syncline, Mohanpur Inaiti anticline and Tejpur syncline. Present study area lies in southern part of Guneshri-Sapotra syncline extending from Guneshri in NE to Sapotra in SW. Fold (F1) axis trending in the NE-SW direction having shallow plunge (10 to 15°). Development of second generation of folding on the NW-SE axis and its interference on the primary NE-SW trending folds has given rise to a small domal structure near Guneshri within Taragarh sandstone. Folding on NE-SW axis has further given rise to small rolls of synclines and anticlines.

Fault:

The rocks of the Vindhyan Supergroup have undergone intense faulting along its western margin of the study area. This has given rise to two major NE-SW trending parallel faults about 20 km apart and a number of conjugate faults. Other faults which

commonly occur in the area include cross faults and oblique faults. The evidences of faulting include tilting and overturning of beds, brecciation, and development of escarpment. Besides the two major faults a few NE-SW trending strike faults and a numbers of NW-SE trending cross faults are present in the study area (Plate-3).

Joints:

Among all the secondary structures joints are very common in all litho units of the study area. It comprises bedding joint, strike joint, oblique joint and dip joint. Especially in upper part of Taragarh sandstone where three sets of joints give rise to cubical blocks. The major sets of joint are shown in plate-4.

Figure- 4: Field photographs of different type of structure of the study area



Fig. 4.1. Compositional banding in rocks of Jhiri Formation, near Bajna.



Fig. 4.2. Cross bedding in Taragarh sandstone, near Dudupura.



Fig. 4.3. Cross bedding in Taragarh sandstone, near Gothra.



Fig. 4.4. Asymmetrical ripple marks, Taragarh sandstone, near Garain.



Fig. 4.5. Three sets of joints, top of Taragarh sandstone, near Gothra.



Fig. 4.6. Warping of strata, Taragarh Formation, quarry section, near Dudupura.



Fig. 4.7. Fault in Taragarh sandstone, near Bichpanya.



Fig. 4.8. Mesoscopic fold in rocks of Indergarh Formation, quarry section, near Kaontipura.



Fig. 4.9. Fault in rocks Taragarh sandstone, near Gangurda.



Fig. 4.10. Striations on sandstone, near Garain.

5.B.6 Metamorphism:

The rocks of Vindhyan Supergroup have not experienced metamorphism, as evident by mineral assemblage and textural relationship of rocks. Though, quartzitic nature of sandstone at places of Indargarh and Taragarh Formation can be explained by overlying load, which may have contributed the higher compaction and consolidation of sandstone. Tectonic activity causes development of secondary structures and enrichment of secondary iron along fault and joints of the study area.

5.B.7 Mineralogy of the glauconite/ ore zones and ore texture:

Glauconite is a clay mineral, occurring in sedimentary rocks which are known to be authigenic in origin. It commonly occurs in amorphous nature and belongs to monoclinic system. It is complex silicates of iron, aluminum and potassium (K,Na)(Fe³⁺,Al,Mg)₂(Si,Al)₄O₁₀(OH)₂. It is translucent to opaque with olive green, yellowish green and bluish green color. It is having light green streak with Hardness of 2 (Mohs scale), average density 2.67, shows platy/micaceous habit and nonmagnetic in nature. It is pleochroic showing dark green, yellowish green, olive green and bluish green color.

Glauconite occurs both in mudrocks and sandstone. Where especially abundant in sand, the rock is commonly named "greensand". Glauconite formation accompanied by green sand sedimentation occurred at particular times on a worldwide basis, notably in the Cambrian and through the Upper Cretaceous and Early Tertiary (Pettijohn et al., 1972, p. 229). It is easily weathered and with one or two exception, does not occur in any abundance as a reworked mineral. As per Indian Bureau of Mines (IBM), as on 01/04/2010, total glauconite resource in India is estimated as 1968 million tones.

Mineralogical studies of 05 nos. of rock/mineral sample were analyzed by XRD method at Mineralogy Lab, GSI, WR, Jaipur. Details of XRD analysis are given in table-6.

Table-6: Details of samples of XRD analysis

S.No	Sample ID	Latitude	Longitude	Remarks	Mineral (%)
1	IT-	26°23'58"	76°52'55.5"	Glauconitic	Quartz- 90
	56/XRD/01			Shale	Mica - 10
					Clinochore- 07
					K-feldspar- 3
2	IT-	26°23'21.8"	76°56'43"	Glauconitic	Quartz- 90
	56/XRD/02			sandstone	K-feldspar- 8
					Mica - 02
3	M-132	26°22'22.6"	76°50'3.3"	Khari	Quartz- 95
				(clay)	K-feldspar- 4
		-31			Mica - 01
4	M-230	26°16'49.4"	76°45'16.5"	Glauconitic	Quartz- 95
		-	UDI	sandstone	Mica - 05
5	M-234	26°16'45.8"	76°45'12.6"	Glauconitic	Quartz- 96
	145	- 0.		sandstone	Mica – 03
	11-1	0,		0 \ 3	Clinochore-01

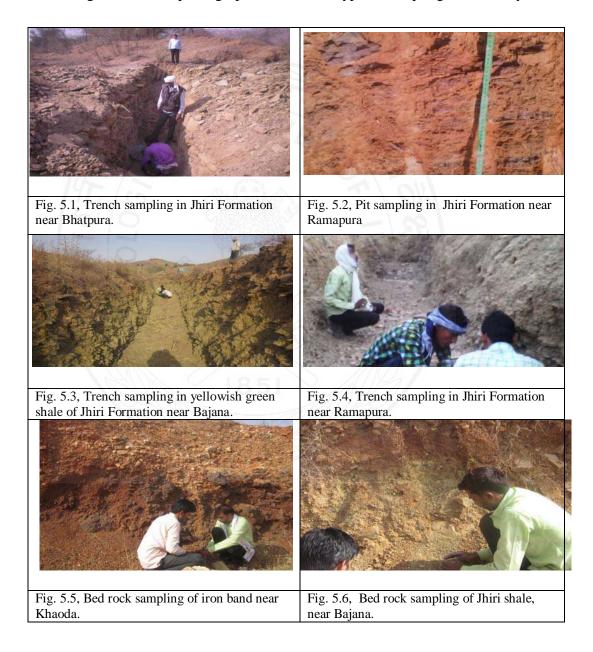
5.B.8 Pitting and trenching:

Pitting is generally carried out to explore the soil profile and to get enrichment of mineral in particular horizon of the soil profile. Trenching is generally carried out across the general strike of the lithounit to understand the depth persistence and spatial extent of litho unit. Field studies reveal that glauconite mineralization is mainly associated with olive green shale of Panna and Jhiri Formations. Taragarh sandstone and shale is also glauconitic but concentration of glauconite is comparatively low as compare to Jhiri and Panna shale. There are very limited outcrops of shale in the study area, as shale occurs in valley portion and mostly concealed under alluvium or along escarp side of hill, where it covered under the scree material. To know the occurrences of glauconitic shale and potash concentration, 80 nos. of pitting / trenching samples were analyzed. 71 nos. of samples were collected from Jhiri formation, 07 nos. of samples were collected from Taragarh Formation and 2 nos. of samples were collected from Panna Formation.

5.B.9 Sampling:

To know the potash content in glauconitic sandstone and shale and compositional variation of different litho units, a total of 323 nos. of bed rock samples, 80 nos. of pitting/trenching samples and 255 nos. of core samples were collected and analyzed. Field photographs of different type of sampling carried out in the study area are shown in figures-5 (5.1 to 5.6).

Figure- 5: Field photographs of different type of sampling in the study area



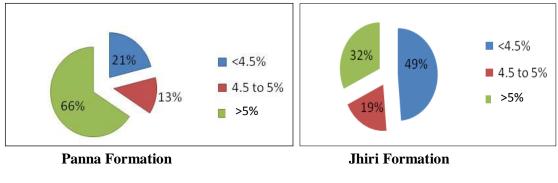
5.B.10 Discussion of results of chemical analysis of samples:

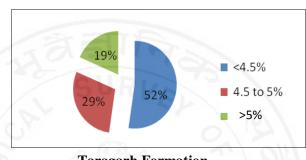
Geochemical analytical results of samples of Tirohan Limestone, Tirohan Conglomerate, Kaimur, Panna, Indergarh, Jhiri, Taragarh and Maihar Formations are shown in Annexure- 1, 2, 3, 4, 5, 6, 7 and 8; respectively. As inferred from mapping and orientation survey, the majority of samples were collected from Panna, Jhiri and Targrah Formations, especially olive to yellowish green shale having indication of glauconite mineralization. The formations wise number of samples and range of K_2O is shown in table -7, it shows that there are appreciable no. of samples having K_2O content in the range from4.5 to 5% and above 5%. The maximum concentration of K_2O in olive green shale of Panna, Jhiri and Tararagrh Formation are analyzed i.e. 7.21, 6.64, 5.93% respectively. The concentration of K_2O in glauconitic sandstone is not appreciable, the majority of samples having K_2O content in the range from 0.04 to 2.23%. Percentage wise range of K_2O concentration of rocks of different formations shows in figure-6. Figure-6 shows content of K_2O (%) in different formations. It reveals that potential zones are associated with Panna, Jhiri and Taragarh Formations.

Table 7: Number of bed rock samples having different ranges of K₂O in different formations

Formation	No. of Samples	No. of Shale	No. of Sandstone	No. of samples (K ₂ O)			
		samples	samples	<4.5%	4.5 to 5%	>5%	
Panna Formation	79	77	2	16	10	50	
Jhiri Formation	195	187	8	94	37	62	
Taragarh Formation	66	51	15	34	19	12	

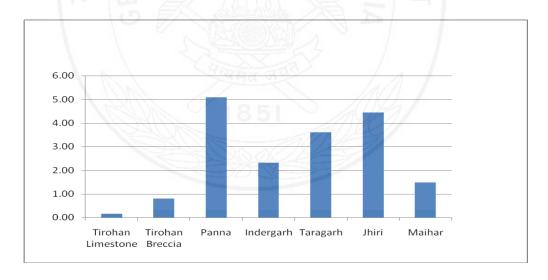
Figure- 6: Percentage of bed rock samples having different ranges of K_2O in different formations





Taragarh Formation

Figure- 7: Average value of K₂O (%) in samples of different formations



Analytical result of core samples of boreholes RKS-1 to RKS-9 is shown in annexure-9 to 17 respectively. It shows the comparatively high concentration of K_2O in olive green shale of Panna, Jhiri and Taragarh formations. The average grades of K_2O in all the 09 boreholes are shown in figure-8. The maximum concentration K_2O is

observed in RKS-8 ie. 6.94% at a depth of 28 to 29 m, in olive shale of Taragarh Formation near Langarpura.

6 5.71 5.38 5.14 5 4.99 4.87 4.94 5 4.08 4.08 4.08 5 2.5 6 KS-1 KS-2 KS-3 KS-4 KS-5 KS-6 KS-7 KS-8 KS-9 Bore Hole No.

Figure- 8: Average grade of K₂O of core samples of boreholes RKS-1 to 9.

5.B.11 Details of interpreted glauconite zones on the basis of geological investigation:

On the basis of geological investigation it has been inferred that most potential zones are olive green, light green, yellowish green shale of Panna and Jhiri formations, which shows encouraging K_2O (>5%) concentration. The sandstone of Taragarh Formation does not show any significant zone, as occurrences of glauconitic is limited to small patch and thin lenses and analytical value of K_2O is also not encouraging. A total 08 nos. of zones have been delineated, out of that four potential areas has been marked in Panna Formation, three zones has been delineated in Jhiri Formation and one zone has delineated in Taragarh Formation. All these 08 zones are mainly having olive to light green shale lithounits. Details of interpreted glauconite zones formation wise are as follows:

(A) Panna Formation Mineralized Zone (PZM):

- (1) PMZ-I: Olive to yellowish green shale near Kaontipura having strike continuity of about 1.5 Km.
- (2) PMZ-II: Olive to yellowish green shale near Bapoti having strike continuity of 0.7 km.
- (3) PMZ-III: Olive to yellowish green shale, 1 km east of Kodai, having strike continuity of 1.0 Km on western limb of syncline.

(4) PMZ-IV: Olive to yellowish green shale near Mahauli, having strike continuity of 1 Km on eastern limb of syncline.

(B) Jhiri Formation Mineralized Zone (JMZ):

- (1) JMZ-1: Olive to yellowish green shale from Adadungar to Ramapura Ghati, having strike continuity of about 10 Km on eastern limb of syncline.
- (2) JMZ-II: Olive to yellowish green shale from Gothra to Grain having strike continuity of about 3.0 Km from on western limb of syncline.
- (3) JMZ-III: Olive to yellowish green shale near Bajna having strike continuity of about 2.5 Km on eastern limb.

(C) Taragarh Fort Formation Mineralized Zone (TMZ):

(1) TMZ-1: Olive to yellowish green shale, having strike continuity of 1 km, near Langrapura.

5.C Geophysical Exploration:

Geophysical exploration has not been conducted during present study.

5.D Geochemical Exploration:

5.D.1 Selection of Geochemical exploration type:

As a part of exploration chemical analysis of major elements (SiO₂, Al₂O₃, Fe₂O₃, CaO, MgO, MnO, K₂O, P₂O₅, TiO₂) of bed rock samples, pitting/trenching samples and core samples were determined.

5.D.2 Methodology of geochemical exploration:

The bed rock/pitting/trenching/core samples were crushed to -80 mesh size. After thorough mixing and coning and quartering method, the desired quantity taken for chemical analysis by XRF method in Chemical Division, GSI, WR, Jaipur.

5.D.3 Grid of Geochemical sampling:

A total 323 nos. of non grid litho samples were collected and analyzed. The outcrops of Panna and Jhiri shale are very scanty in the study area, mostly it concealed under alluvium and scree material. Bed rock samples have been collected from shale, sandstone and limestone rocks of different formation, to know the content of major

oxides especially to know spatial distribution of K_2O concentration. The location of sample has been marked with hand held GPS.

5. D.4 Statistical analysis of geochemical data and interpretation of anomalous zones:

Descriptive statistics of analytical data of bed rock samples of different formations and the core samples of scout boreholes is shown in table 8 & 9 respectively. More than 5% K_2O concentration is considered as anomalous value for present study. The mean value of K_2O in rocks of Panna and Jhiri Formation are 5.08 and 4.45% respectively, which is comparatively high when compare to rocks of other formation. This indicates that an anomalous zone is associated with olive shale of Panna and Jhiri Formation.

Correlation matrix (Table 10 & 11) of major oxides of bed rock samples of Panna and Jhiri formations were prepared from the analytical data. In Panna Formation K_2O shows strong positive correlation with Al_2O_3 , MgO and TiO_2 and strong negative correlation with CaO. Samples of Jhiri Formation show strong positive correlation with Al_2O_3 and MgO.

Table- 8: Descriptive statistics of bed rock samples of different formation of the study area

Formation	Parameters	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
	Mean	52.35	3.01	2.01	8.11	7.33	7.35	0.86	0.15	0.74	0.04
4)	Median	55.9	2.675	1.55	0.33	5.95	0.02	0.665	0.06	0.84	0.015
Tirohan Limestone	Standard Deviation Minimum Maximum	39.67 1.17 94.1	2.03 0.25 5.86	1.40 0.53 4.86	13.67 0.06 35.3	7.39 0.07 18.4	14.17 0.01 36.9	0.90 0.005 2.58	0.27 0.01 0.81	0.29 0.02 0.84	0.05 0.005 0.15
	Count	94.1	3.60	4.60	33.3	8	30.9	2.36	0.81	0.64	0.13
	Mean	67.86	10.11	14.57	0.67	0.69	0.15	1.14	0.79	0.73	0.05
ii	Median	71.5	9.81	2.225	0.36	0.81	0.13	0.495	0.73	0.73	0.03
Tirohan Breccia	Standard Deviation	24.64	7.91	22.42	1.00	0.50	0.18	1.58	1.38	0.25	0.03
ųo.	Minimum	21.1	0.97	0.25	0.01	0	0	0	0.01	0.12	0.02
Tir	Maximum	97.4	21.64	60.29	3.28	1.6	0.51	4.72	4.4	0.84	0.11
	Count	10	10	10	10	10	10	10	10	10	10
	Mean	59.06	21.56	5.38	0.04	1.76	2.90	0.10	5.08	0.80	0.06
	Median	59.4	22.04	5.4	0.04	1.75	0.56	0.08	5.32	0.81	0.06
ıa	Standard										
Panna	Deviation	6.28	3.16	1.69	0.03	0.45	4.49	0.07	1.06	0.16	0.01
P	Minimum	45.4	5.37	0.21	0	0.21	0.08	0.01	0.76	0.21	0.02
	Maximum	91	27.86	8.72	0.16	3.51	24.1	0.38	7.21	1.59	0.12
	Count	79	79	79	_ 79	79	79	79	79	79	79
					51						

•											
	Mean	73.65	16.44	2.16	0.03	0.69	0.12	0.38	2.32	0.87	0.05
	Median	67.19	20.25	0.85	0.01	0.55	0.12	0.09	2.44	0.84	0.05
arł	Standard										
erg	Deviation	14.65	10.04	2.38	0.04	0.69	0.07	0.72	2.14	0.24	0.03
Indergarh	Minimum	58	1.45	0.2	0	0.13	0.05	0.005	0	0.51	0.01
	Maximum	94.8	27.59	6.37	0.14	2.47	0.23	2.25	5.65	1.49	0.1
	Count	10	10	10	10	10	10	10	10	10	10
	Mean	70.22	14.15	4.19	0.23	1.77	1.11	0.36	3.60	0.73	0.06
	Median	66.6	16.16	4.41	0.05	2.04	0.39	0.09	4.43	0.82	0.05
ų.	Standard										
ıgaı	Deviation	10.90	5.38	1.90	1.22	0.73	2.29	0.96	1.84	0.26	0.02
Taragarh	Minimum	49.7	1.17	0.38	0	0.01	0.01	0.005	0.01	0.06	0.02
Τ	Maximum	96.2	19.94	8.03	9.84	3.3	12.7	4.94	5.93	1.06	0.16
	Count	66	66	66	66	66	66	66	66	66	66
			- 73	511	16						
	Mean	59.10	19.53	6.72	0.05	1.99	2.77	0.10	4.45	1.00	0.06
	Median	58.9	20.05	6.85	0.04	2.08	1.69	0.09	4.56	0.96	0.06
	Standard				V	1					
Jhiri	Deviation	6.93	3.49	1.32	0.07	0.40	4.09	0.07	1.02	0.23	0.03
J.	Minimum	27.3	1.22	1	0.01	0.06	0	0.005	0.03	0.06	0.02
	Maximum	92.8	24.46	11.31	0.84	3.58	35.8	0.85	6.64	1.5	0.22
	Count	195	195	195	195	195	195	195	195	195	195
	115/10	2		200				57			
	Mean	64.35	17.84	4.01	0.28	2.95	0.37	3.63	1.48	0.90	0.15
	Median	63.8	18.28	4.35	0.3	2.79	0.43	4.705	0.14	0.84	0.09
ıar	Standard	4 2	=/	1.41.1.				- 1			
Maihar	Deviation	2.74	2.00	1.73	0.20	1.04	0.18	2.28	2.76	0.12	0.13
Z	Minimum	61.7	15.14	1.61	0.02	1.99	0.11	0.22	0.02	0.84	0.06
	Maximum	68	19.66	5.71	0.5	4.25	0.51	4.89	5.62	1.07	0.34
		-	- 777								

Table- 9: Descriptive statistics of core samples of scout borehole RKS-1 to RKS-9

Bore	Parameters	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na₂O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
Hole						10/	· \				
No.			(%)								
RKS-1	Mean	60.33	21.35	6.71	0.39	2.19	0.07	5.72	0.04	0.90	0.08
	Median	59.53	21.845	6.755	0.33	2.21	0.07	5.91	0.025	0.92	0.05
	Minimum	57.03	14.69	4.56	0.26	1.3	0.05	3.3	0.01	0.63	0.02
	Maximum	73.41	22.96	9.38	0.85	2.58	0.08	6.34	0.14	1.02	0.46
	Count	38	38	38	38	38	38	38	38	38	38
RKS-2	Mean	61.92	20.73	6.30	0.32	1.98	0.08	5.38	0.06	1.02	0.07
	Median	61.55	20.8	6.19	0.3	2.04	0.08	5.42	0.05	0.96	0.05
	Minimum	57.55	13.05	4.57	0.2	1.2	0.05	3.58	0.02	0.72	0.04
	Maximum	74.72	23.17	9.03	0.63	2.33	0.11	6.36	0.14	1.33	0.28
	Count	33	33	33	33	33	33	33	33	33	33

RKS-3	Mean	61.84	20.51	6.77	0.28	1.92	0.08	5.15	0.06	1.23	0.05
	Median	61.58	20.29	6.66	0.27	1.96	0.08	5.13	0.03	1.21	0.05
	Minimum	59.55	17.03	5.01	0.23	1.5	0.06	4.6	0.02	0.86	0.04
	Maximum	64.6	22.83	9.61	0.44	2.17	0.1	5.95	0.22	1.63	0.1
	Count	25	25	25	25	25	25	25	25	25	25
RKS-4	Mean	60.02	23.19	6.88	0.33	1.61	0.11	5.00	0.04	0.84	0.06
	Median	59.97	23.14	7.26	0.31	1.6	0.1	5.01	0.04	0.84	0.06
	Minimum	58.68	21.99	4.67	0.24	1.38	0.09	4.65	0.02	0.78	0.05
	Maximum	62.12	24.19	9.13	0.52	1.8	0.13	5.32	0.06	0.89	0.08
	Count	25	25	25	25	25	25	25	25	25	25
RKS-5	Mean	62.54	19.89	6.96	0.38	1.84	0.07	5.00	0.06	0.97	0.05
	Median	62.74	19.9	6.9	0.34	1.83	0.07	4.94	0.04	0.91	0.04
	Minimum	59.05	17.4	4.55	0.28	1.43	0.05	4.22	0.02	0.77	0.03
	Maximum	65.94	21.57	10.36	1.06	2.15	0.09	5.89	0.27	1.23	0.12
	Count	41	41	41	41	41	41	41	41	41	41
RKS-6	Mean	60.83	22.65	6.86	0.27	1.56	0.08	4.87	0.04	0.86	0.06
	Median	60.75	22.72	6.93	0.27	1.55	0.08	4.88	0.03	0.86	0.06
	Minimum	59.08	21.66	5.13	0.2	1.27	0.07	4.42	0.02	0.76	0.05
	Maximum	62.91	23.79	9.12	0.33	1.77	0.09	5.23	0.1	0.94	0.08
	Count	27	27	27	27	27	27	27	27	27	27
RKS-7	Mean	76.80	10.65	5.53	0.39	1.32	0.04	2.70	0.08	0.56	0.07
	Median	69.85	11.53	4.37	0.16	1.4	0.03	2.3	0.03	0.62	0.08
	Minimum	58.42	1.98	1.01	0.04	0.01	0	0.08	0.01	0.03	0.02
	Maximum	93.91	19.55	19.43	4.44	3.29	0.1	5.29	0.54	1.16	0.16
	Count	19	19	19	19	19	19	19	19	19	19
RKS-8	Mean	71.27	13.00	4.03	1.09	1.76	0.01	4.91	0.06	0.82	0.09
	Median	70.71	12.26	3.9	0.31	1.72	0.005	5	0.06	0.8	0.1
	Minimum	60.95	5.09	1.6	0.1	0.82	0.005	2.42	0.01	0.42	0.06
	Maximum	87.44	20.32	5.61	5.24	3.63	0.03	6.94	0.15	1.11	0.14
	Count	21	21	21	21	21	21	21	21	21	21
RKS-9	Mean	67.12	15.17	8.59	0.27	1.27	0.01	4.51	0.11	0.88	0.08
	Median	64.90	15.83	9.28	0.29	1.45	0.01	5.11	0.13	0.88	0.10
	Minimum	62.94	6.98	2.77	0.04	0.09	0.01	0.31	0.01	0.62	0.03
	Maximum	87.83	17.47	10.35	0.42	1.59	0.06	5.44	0.22	1.00	0.11
	Count	26	26	26	26	26	26	26	26	26	26

Table- 10: Correlation matrix of analytical data of major oxides detected in bed rock samples of Panna Formation.

	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na2O	K2O	TiO_2	P_2O_5
SiO_2	1									
Al_2O_3	-0.38	1								
Fe_2O_3	-0.33	0.27	1							
MnO	0.08	-0.12	0.21	1						
MgO	-0.14	0.41	0.44	-0.13	1					
					-					
CaO	-0.64	-0.34	-0.09	-0.09	0.36	1				
Na2O	-0.08	0.31	0.15	-0.19	0.19	-0.13	1			
K2O	-0.06	0.76	0.24	0.03	0.65	-0.64	0.20	1		
TiO_2	-0.27	0.70	0.14	-0.15	0.60	-0.36	0.24	0.77	1	
P_2O_5	-0.06	0.36	0.28	0.08	0.11	-0.30	0.34	0.40	0.40	1

Table- 11: Correlation matrix of analytical data of major oxides detected in bed rock samples of Jhiri Formation.

	SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na2O	K2O	TiO ₂	P_2O_5
SiO_2	1	?			A	d i	Ū			
Al_2O_3	-0.34		X .dd			71				
Fe_2O_3	-0.31	0.47	L L			/				
MnO	-0.29	-0.42	0.05		3	/	- /			
MgO	-0.52	0.65	0.46	0.14	1	1.1	/			
CaO	-0.68	-0.40	-0.19	0.50	0.01	1				
Na2O	0.24	-0.09	-0.10	0.00	0.08	-0.11	1			
K2O	-0.21	0.80	0.29	-0.33	0.54	-0.43	-0.18	1		
TiO_2	-0.14	0.62	0.36	-0.36	0.42	-0.34	-0.17	0.39	1	
P_2O_5	-0.16	0.01	0.11	0.38	0.23	0.09	-0.02	0.06	0.00	1

5.D.5. Identification of anomalous zones with strike length and thickness:

The comparatively high concentration of K_2O is observed in olive, light green to yellowish khaki shale. The scout borehole RKS- 5, drilled in Jhiri Formation near Gothra indicates shale having glauconite continuing up to 45 m. The scout borehole RKS-4 and 6, drilled in Panna Formation, which indicate shale having glauconite continuing up to depth of

30 m near Kanotipura and Bapoti. The scout borehole RKS-8, drilled in Taragarh Formation near Langrapura which indicate total 29 m thick light green glauconite bearing shale. Details of anomalous zone have been given in table-12. The thickness of zone is considered as the true thickness of glauconite bearing shale having average grade of K₂O more than 4.5% in core samples.

Table-12: Details of anomalous zone with strike length and thickness

S.	Mineralized	Formati	Major	Approxim	Cumulative	Average	Reference
No	Zone	on	litholog	ate	true thickness	Grade of	
			y	Strike	of glauconite	K ₂ O (%) in	
				length	bearing zone	core/bed rock	
				(Km)	(m)	sample	
1	PMZ-I	Panna	Shale	1.5	25.43	4.88	Borehole RKS-6
2	PMZ-II	Panna	Shale	0.7	24.75	5.0	Borehole RKS-4
3	PMZ-III	Panna	Shale	1.0	10*	4.2#	BRS data
4	PMZ-IV	Panna	Shale	1.0	15*	5.75##	BRS data
5	JMZ-1	Jhiri	Shale	10.0	24.50	5.72	Borehole RKS-1
	176	10	8		28.50	5.38	Borehole RKS-2
	1/2	1/0	1		23.30	5.114	Borehole RKS-3
6	JMZ-II	Jhiri	Shale	3.0	38.01	4.99	Borehole RKS-5
			_		20.66	5.11	Borehole RKS-9
7	JMZ-III	Jhiri	Shale	2.5	8*	3.94###	BRS data
8	TMZ-I	Taragar h	Shale	1.0	23.76	5.21	Borehole RKS-8

^{*} Exposed thickness.

[#] Average value of analytical results of 7 nos. of bed rock samples collected from PMZ-III (Maximum K₂O value of 4.71% in sample no.PS-7).

^{***} Average value of analytical results of 22 nos. of bed rock samples collected from PMZ-IV.

**** Average value of analytical results of 57 nos. of bed rock samples collected from JMZ-III (Maximum K₂O value of 5.21% in sample no.JS-13).

CHAPTER-6

INTEGRATION OF GEOLOGICAL AND GEOCHEMICAL EXPLORATION DATA AND INTERPRETATION THERE OFF

The investigation comprises both geological and geochemical aspects of exploration for preliminary search for potash in glauconitic sandstone/shale of Vindhyan Supergroup in parts of Saporta - Karauli sub-basin. Large scale geological mapping was carried out of 150 sq. km area to delineate the glauconitic litho units.09 nos. of scout boreholes were drilled to ascertain the depth persistence and strike continuity of glauconite bearing shale and sandstone. Large scale geological map (plate-4) shows that major glauconitic litho units are associated with rocks of Panna and Jhiri formations of Rewa Group of upper Vindhyan. Occurrences of glauconitic sandstone are also reported first time in sandstone of Taragarh Formation and lower part of Tirohan Limestone Formation.

As the investigation was proposed for preliminary search of potash (K_2O) in glauconitic rocks. The bed rock samples were collected from all the glauconite bearing lithounits to assess the potash content of the rocks and to know the spatial distribution of comparatively high potash bearing rocks. To know sub-surface distribution of potash in glauconitic rock, 09 nos. of scout boreholes were drilled, up to maximum depth of 45 m. The majority of samples were collected from glauconite bearing olive green, light green, yellowish green shale of Panna and Jhiri Formation. Geochemical aspect comprises analysis of major oxides of 323 nos. of non-grid bed rocks samples and 80 nos. of pit/trench samples. Analytical result of bed rock samples are given in annexure-1 to 8. The K_2O content equal to and >5% has been taken as cut off grade of potash.

The integration of geological and geochemical data have been done to decipher the high potash bearing glauconitic shale/sandstone zone. Integrated geological and geochemical map shown in plate-5. The range of K_2O (%) of samples has been shown in different colour, dark green colour circle shown as samples having equal to and >5% K_2O content. The map shows that high concentration of K_2O in bed rock samples

and pit/trench samples, ocuur only in glauconitic bearing shale zone of Panna and Jhiri Formation. A small patch with more than 5% K_2O is also associated with light green shale of Taragarh Formation. The samples collected from glauconitic sandstone does not show encouraging values of potash in comparison to olive to light green glauconitic shale. The occurrences of high potash content in glauconitic shale of Panna and Jhiri formations are also well supported by analytical result of core samples of scout boreholes RKS-1, 2, 3, 4, 5, 6 and 9.

On the basis of geological and geochemical data, a total 08 nos. of mineralized zones has been delineated for further investigation. There are four zones has been marked in Panna Formation i.e. PMZ-I, PMZ-II, PMZ-III and PMZ-IV. Three zones in Jhiri Formation i.e. JMZ-I, JMZ-II & JMZ-III and one zone TMZ-I in Taragarh Formation.



CHAPTER-7

MINERAL PROSPECT

7.1 Surface indication of mineralisation

The surface indications of glauconite mineralization in the area are manifested by the presence of olive green, yellowish green and olive gray shale. Though major part of shale is concealed under either alluvial or scree material. The nala sections are best sites to get first impression for presence of glauconite bearing litho unit in the form of boulder/gravel. Investigation of scree material along slope may give indication of glauconite bearing rock. The soil of the area may have very high potash content. Field photograph of surface indication of glauconite in the study is shown in figure: 9 (9.1 & 9.2).

Figure- 9: Field photograph of surface indication of glauconite in the study



Fig. 9.1. Exposure of light green to gray shale containing glauconite, in nala section near Ramapura

Fig. 9.2. Fragments of olive green glauconitic sandstone

7.2 Mode of Occurrence:

Field evidences and petrological studies of surface and sub-surface samples shows glauconite bearing shale horizons occurs as bands. In the study area presence of glauconite is reported from sandstone of Tirohan Formation, shale and sandstone of Panna Formation, shale and sandstone of Jhiri Fornation, Taragarh Formation and Maihar Formation.

In shale of Panna and Jhiri Formations, the glauconite is present fine to medium grained and occurs as thin laminations. In sandstone, glauconite occurs as disseminations. Near Garain in Baniya Khora, glauconite mineralization is associated with coarse grained sandstone and it is disseminated type and patchy occurrence indicates detrital origin. In the borehole RKS-7, a thin band (30 cm) of glauconitic sandstone is reported. Field evidence indicates that the concentration of glauconite is not persistent, both laterally and depth wise. Field photographs of occurrence of glauconitic sandstone/shale of the study area shown in figure: 10 (10.1 to 10.16).

Figure-10: Field photographs of occurrence of glauconitic sandstone/shale of the study area (10.1 to 10.16)



Fig. 10.1. Thin band of glauconitic sandstone, near Mahauli, Tirohan Formation,



Fig.10.2. Fragment of glauconitic sandstone, observed in quarry dump near Kaontipura, Panna Formation,



Fig. 10.3.Glauconitic shale intercalated with maroon shale, core sample-RKS-6, near Kaontipura.



Fig. 10.4. Thin band of glauconitic sandstone, Jhiri formation, near Rampura.



Fig.10.5. Jhiri Formation, lamination of glauconitic sandstone, near Dudupura.



Fig.10.6. Jhiri Formation, thin band of glauconitic sandstone, near Dudupura.



Fig.10.7. Thin band of glauconitic sandstone in Taragarh sandstone. Panna Khora, near Garain.



Fig.10.8. Jhiri Formation, fragment of glauconitic sandstone, observed in quarry dump, near Dudupura.



Fig.10.9. Core sample of glauconitic sandstone, borehole RKS-5, Jhiri Formation, near Gothra



Fig.10.10. Core sample of glauconitic shale, borehole RKS-5, Jhiri Formation, near Gothra



Fig.10.11. Core sample of glauconitic sandstone, Taragarh sandstone, borehole RKS-7, near Garain

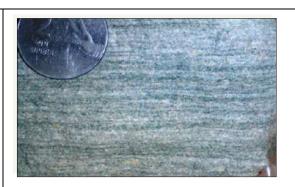


Fig.10.12. Glauconitic sandstone in Taragarh sandstone dug well section, near Saimarda (M-132).



Fig.10.13. Thin band of glauconitic sandstone in Taragarh sandstone, Panna Khora, near Gangurda (M-119).



Fig.10.14. Fragment of glauconitic sandstone in dug well dump, Taragarh sandstone, near Saimarda (M-151).



Fig.10.15. Glauconitic sandstone, Maihar sandstone, near Rajor in quarry section.



Fig.10.16. Thin lamination of glauconite rich portion associated with sandstone, Maihar sandstone, near Rajor in quarry

7.3 Nature of Mineralisation:

In the study area glauconite mineralization is mainly associated with a Panna shale, Jhiri shale and Taragarh sandstone/shale, however; glauconitic sandstone is also reported from lower part of Tirohan limestone near Mahauli. The glauconite mineralization in the form of disseminations is associated at places with sandstone. In major portion of the area mineralization is bedded especially in shale. In shale thickness of glauconitic horizon is comparatively more which has persistence along strike. The nature of glauconite mineralization in the study area is shown in figure: 10 (10.1 to 10.16).

7.4 Details of Mineralised Zones:

The main mineralized zone is olive green shale of Panna, Jhiri and Taragarh Formations. Total 08 zones have been delineated on the basis of mapping and chemical analysis of bed rock and core samples. Details of mineralized zone are given in table -12 and shown in plate-3.

7.5 Genesis of glauconite mineral / Genetic model for mineralisation:

Glauconite has polygenetic origin. Unlike the other clay minerals, glauconite does not form from hydrothermal or terrestrial weathering of pre-existing minerals. Geochemical evidences suggest that glauconite formation occurs in sea water at low temperature and in an environment which is neither strongly oxidizing nor reducing. Optimum depth for glauconite genesis appears to be between 50 and 100 m. However, these parameters are hard to define because, once formed, glauconite is stable in sea water and can survive transportation in a marine environment. Thus the glauconite is found disseminated in marine mudrock, in clean well-sorted cross-bedded sand shoals and as a minor constituent of basinal turbidities (Richard C. Selley., Applied Sedimentology, 1988, p. 294). Glauconite generally forms in following ways:

1. Breakdown of terriginous minerals: Diagenesis of amphiboles, pyroxenes, feldspar and mica under shallow marine condition and reducing environment can form glauconite.

- 2. Formation within organic skeletons: In modern deposit, glauconite forms as internal cast of foraminiferal shell and sponge specules.
- 3. Primary precipitation: glauconite forms as flocculent precipitate on the sea floor by the reaction of colloidal ferric oxide and colloidal potassium silicates.
- 4. Chemical replacement: glauconite may form by replacement of feldspar or pyroxenes but it is rare.



CHAPTER-8

EXPLORATION BY SCOUT DRILLING

8.1 Stage of exploration as per mineral content rule:

The preliminary search of potash in glauconitic sandstone/shale of Vindhyan Supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan, has been carried under UNFC G4 stage.

8.2 Methodology of drilling with the details of type of drilling:

The drilling has been carried out using diamond bits. The initial core size was maintained at 'HQ' size and subsequently reduced to NQ size (46 m core diameter) till the completion of the boreholes. Triple tube core barrel was used to obtain enhance core recovery.

8.3 Boreholes Planning:

Investigation was taken with an objective to delineated glauconitic sandstone/shale of rocks of Vindhyan Supergroup in Sapotra –Karauli sub-basin. About 400 Sq. km area were covered under aerial reconnaissance survey. On the basis of orientation study, 150 Sq, km covered under Large Scale Mapping. The mapping and bed rock sampling infer that potential glauconite bearing litho-units are belonging to Panna, Jhiri and Taragarh Formations of Vindhyan Supergroup. The outcrops of glauconitic shale are mostly concealed under alluvium and thick scree materials along foothills. To know the depth persistence and strike continuity, scout boreholes were planned to assess the sub-surface potential of glauconite in the study area. A total 09 nos. of shallow scout boreholes were drilled having total drilling of 300 m. The glauconite bearing shale is exposed on both side of syncline structure along foot hills and valley area.

All nine scout borehole are vertical. The scout boreholes RKS-1, 2, & 3 were planned on eastern limb, while RKS-5 & 9 were planned on western limb to know depth persistence and strike continuity of olive green shale of Jhiri Formation. The scout boreholes RKS-4 & 6 were drilled in Panna Formation in southern part of the study area. The scout boreholes RKS-7 & 8 were drilled in sandstone of Taragarh

Formation, to assess the depth persistence and strike continuity of glauconitic sandstone, as observed in outcrop as well as in dump of dug well.

8.3.1 Summary of scout boreholes:

As a part of sub-surface instigation total 09 nos. of shallow boreholes were drilled with maximum depth of 45 m. in Sapotra area. The summary of scout boreholes of the study area is given in table-:13.

Table- 13: Summary of scout boreholes (RKS-1 to RKS-9) of the study area

Borehole no.	Total depth (m)	Date of commencement	Date of completion	Azimuth of borehole	RQD (%)	Rock type
RKS-1	34.50	22/02/16	28/02/16	Vertical	8.80	Shale
RKS-2	35.00	02/03/16	08/03/16	Vertical	4.97	Shale
RKS-3	30.50	13/03/16	18/03/16	Vertical	13.5	Shale
RKS-4	30.00	20/03/16	26/03/16	Vertical	3.50	Shale
RKS-5	45.00	31/03/16	07/04/16	Vertical	21.9	Shale
RKS-6	30.00	10/04/16	15/04/16	Vertical	22.23	Shale
RKS-7	30.00	18/04/16	23/04/16	Vertical	18.2	Sandstone /shale
RKS-8	30.00	24/04/16	02/05/16	Vertical	7.20	Sandstone /shale
RKS-9	35.00	04/05/16	08/05/16	Vertical	18.59	Shale

The Rock quality designation (RQD) depends upon the frequency of weak discontinuity in the rock mass. RQD can be graded as Excellent (90% - 100%), Good (75% - 90), Fair (50% - 75%), Poor (25% - 50%) and very poor (<25% RQD).

8.4. Borehole logging

The cores of nine boreholes were logged incorporating all the details about lithology, mineralization, core angle, core recovery, RQD and structural features. All these details are recorded in the borehole log register. Summarized lithologs are given in Annexure-18 to 26. Litholog of the scout boreholes RKS 1 to RKS-9 drilled in study area is shown in plate-6.

8.5 Core recovery percentage:

Glauconite bearing litho units in the study area is shale of Panna, Jhiri and Taragarh Formations. The shale has intercalations of thin band of sandstone/siltstone. The shale is weathered and highly jointed, hence triple tube core barrel is used to appropriate core recovery. The general core recovery in weathered zone varies from 25 to 50 %. Overall core recovery is more than 90%.

8.6 Mineralogy of the ore zone:

The glauconite mineralization is associated with shale and sandstone in the study area. The studies reveal that other mineral associated with shale is quartz, feldspar and mica.

8.7 Borehole deviation test and methodology:

Deviation test were not conducted, as all 09 nos. of scout boreholes are vertical and having shallow depth (from 30 to 45 m).

8.8 Methodology of the ore zone sampling:

After examination of the core, the mineralized zones are demarcated and sampling zones are fixed. The conventional method of sampling of drill cores was followed and it was restricted within the individual run of the borehole. The normal length of the core sample was kept at 1.00 m, while at some places it is 0.75 m.

8.9 Sample preparation, Chemical analysis and laboratory procedures:

The mineralized zones were sampled by splitting the core longitudinally into two equal halves mechanically by core splitter. One half of the split portion was crushed and powdered to -80 mesh size by using iron pestles and mortars. The powdered sample was reduced by coning and quartering and requisite sample submitted to the Chemical Division, GSI, WR, Jaipur, where -80 mesh sample is powdered to -200 mesh from which analysis is being done by XRF method and representative sample is preserved as duplicate sample for further studies.

The analysis of following 9 elements i.e. K₂O, P₂O₅, CaO, MgO, SiO₂, MnO, TiO₂, Al₂O₃, Fe₂O₃, has been carried out by XRF (Power Diffraction) method, at Chemical Division, Geological Survey of India, Western Region, Jaipur. The XRD analysis has been carried out at XRD Division, GSI, WR, Jaipur.

8.10 Check samples:

To know the accuracy and reproducibility of the machine, check analysis has been carried out at regular interval and correlated with the standards.

8.11 Details of intersected ore zones of the boreholes drilled and their correlation:

Total 09 nos. of scout borehole were drilled. The Litholog of the scout boreholes RKS 1 to RKS-9 drilled in study area, shown in plate-6. Details of mineralized zones intersected in scout borehole no. RKS-1 to 09 is shown in table -14 to 21. Glauconite mineralized zones were calculated at 4.5% K₂O cut off.

Borehole RKS-1:

The first borehole RKS-1 is located at Dudupura village and is drilled in Jhiri Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing shale/sands. The borehole was drilled to a depth of 34.50 m. It has intersected fractured fine grained light to grey band of siltstone and light green glauconitic shale. The geochemical results of core sample and summarized litholog given in Annexure-9 and Annexure-18 respectively. The analytical results of core samples of the borehole indicate potash bearing zone are as given below:

Table- 14: Details of mineralized zones intersected in scout borehole RKS-1.

Zone	1 11 11 11 11 11 11 11 11 11 11 11 11 1	zone along ole (m)	Width of zone along borehole (m)	True thickness (m)	Grade of K ₂ O (%)
Zone-1	6	33.75	29	24.5	5.72

Borehole RKS-2

The borehole RKS-2 is located at Ramapura Ghati near Sapotra village and was drilled in Jhiri Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing mineralized zone JMZ-I. The borehole was drilled to a depth of 35.00 m. It has intersected fractured fine grained maroon colored siltstone, maroon shale and light green glauconitic shale. The geochemical analytical results of core samples and summarized litholog given in Annexure-10 and Annexure-19; respectively.

The analytical result of core samples of the borehole indicates potash bearing zone are as given below:

Table- 15: Details of mineralized zones intersected in scout borehole RKS-2.

Zone	Depth of z	one along	Width of	True thickness	Grade of K ₂ O
	borehole (m)		zone along	(m)	(%)
			borehole (m)		
Zone-I	3	35	32	28.25	5.38

Borehole RKS-3

The borehole RKS-3 is located at Dauljipura near Sapotra village and was drilled in Jhiri Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing glauconitic shale/sandstone. The borehole was drilled to a depth of 30.50 m. It has intersected fractured brownish shale with thin bands of olive coloured shale, light brown to olive colored shale and light green shale. The geochemical analytical results of core samples and summarized lithologs given in Annexure-11 and Annexure-20 respectively.

The analytical results of core samples of the borehole indicates potash bearing zone are as given below:

Table- 16: Details of mineralized zones intersected in scout borehole RKS-3.

Zone	1 1 1 1 1 1 1	f zone along shole (m)	Width of zone along borehole (m)	True thickness (m)	Grade of K ₂ O (%)
Zone-I	6	30.5	24.5	23.3	5.14

Borehole RKS-4

The borehole RKS-4 is located at Bapoti near Sapotra village and was drilled in Panna Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing glauconitic shale/sandstone. The borehole was drilled to a depth of 30.00 m. It has intersected fractured borwn to yellow shale and grey to light green shale. The geochemical analytical results of core sample and summarized litholog given in Annexure-12 and Annexure-21; respectively.

The analytical results of core samples of the borehole indicate potash bearing zone are as given below:

Table- 17: Details of mineralized zones intersected in scout borehole RKS-4.

Zone	Depth	of zone along	Width of	True thickness	Grade of K ₂ O
	borehole (m)		zone along	(m)	(%)
			borehole (m)		
Zone-I	5	30	25	24.75	5

Borehole RKS-5

The borehole RKS-5 is located at Gothra near Sapotra village and was drilled in Jhiri Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing glauconitic shale/sandstone. The borehole was drilled to a depth of 45 m. It has intersected olive green to cream coloured shale and olive green shale. The geochemical analytical results of core samples and summarized litholog given in Annexure-13 and Annexure-22; respectively.

The analytical results of core samples of the borehole indicate potash bearing zone are as given below:

Table- 18: Details of mineralized zones intersected in scout borehole RKS-5.

Zone	Depth of zone along borehole (m)		Width of zone along borehole (m)	True thickness (m)	Grade of K ₂ O (%)
Zone-I	4	45	41	38.01	4.99

Borehole RKS-6

The borehole RKS-6 is located at Kaontipura near Sapotra village and was drilled in Panna Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing glauconitic shale/sandstone. The borehole was drilled to a depth of 30.00 m. It has intersected fractured light brown to reddish shale, light brown to olive green colored shale. The geochemical analytical results of core samples and summarized litholog given in Annexure-14 and Annexure-23; respectively.

The analytical results of core samples of the borehole indicate potash bearing zone are as given below:

Table- 19: Details of mineralized zones intersected in scout borehole RKS-6.

Zone	Depth of zone		Width of	True	Grade of K ₂ O
	along borehole		zone along	thickness (m)	(%)
	(m)		borehole (m)		
Zone-I	3	30	27	25.43	4.88

Borehole RKS-7

The borehole RKS-7 is located at Garain ki Gwari and was drilled in Taragarh Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing glauconitic shale/sandstone. The borehole was drilled to a depth of 30.00 m. It has intersected mainly light grey to brownish sandstone and not intersected any glauconite shale/sandstone zones. The geochemical analytical results of core samples and summarized litholog given in Annexure-15 and Annexure-24; respectively. The analytical results show no encouraging values of K₂O in the core samples.

Borehole RKS-8

The borehole RKS-8 is located at Langarapura and was drilled in Taragarh Fort Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing glauconitic shale/sandstone. The borehole was drilled to a depth of 30.00 m. It has intersected fine grained grey to light brown sandstone, grey shale and olive green shale. The geochemical analytical results of core samples and summarized litholog given in Annexure-16 and Annexure-25 respectively.

The analytical results of core samples of the borehole indicate potash bearing zone are as given below:

Table- 20: Details of mineralized zones intersected in scout borehole RKS-8.

Zone	Depth of zone		Width of	True thickness	Grade of K ₂ O
	along borehole		zone along	(m)	(%)
		(m)	borehole (m)		
Zone-I	1	6	5	4.95	5.21
Zone-II	10	29	19	18.81	5.21

Borehole RKS-9

The borehole RKS-9 is located at Garain village and was drilled in Jhiri Formation. The borehole was planned to probe the subsurface continuity of the glauconite bearing glauconitic shale/sandstone. The borehole was drilled to a depth of 35.00 m. It has intersected green to brown shale and olive green shale. The geochemical analytical results of core samples and summarized litholog given in Annexure-17 and Annexure-26 respectively.

The analytical results of core samples of the borehole indicates potash bearing zone are as given below:

Table- 21: Details of mineralized zones intersected in scout borehole RKS-9.

Zone		of zone along rehole (m)	Width of zone along borehole (m)	True thickness (m)	Grade of K ₂ O (%)
Zone I	1/-	20	22	20.66	<i>E</i> 11
Zone-I	1/	30	23	20.66	5.11

CHAPTER-9

RECONNIASSANCE MINERAL RESOURCES (334)

9.1 Introduction:

The calculation of resource of prospects is done at every stage right from preliminary to last stage of exploration and mining. Present assignment, entitled "Preliminary search of potash in glauconitic sandstone/shale of Vindhyan Supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan, has been carried out under G-4 stage and the resources have been estimated under 334 category of United Nations Framework Classification (UNFC).

9.2 Detailed description of zones:

The glauconitic zone is considered here as the width containing visible glauconite mineral and analytical result of K_2O equal to or greater than 4.5%. On the basis of surface and sub-surface investigation total 08 nos. of glauconite mineralized zones has been demarcated, details are given in table-12.

9.3 Core recovery:

Core recovery plays an important role in computation of ore resources. Therefore, the core recovery should be very high at least in the mineralized zone. The core recovery within the mineralized zone in all the boreholes is in the range from 90 to 95%.

9.4 Cut off grade:

For the correlation of mineralized zone and calculation of resource, mineralized zones were calculated at 4.5% K₂O cut off.

9.5 Correlation of zones:

A total of 9 nos. of scout boreholes were drilled in the study area, during FS 2015-16. 05 nos. of boreholes drilled in Jhiri Formation, out of that 03 nos. of boreholes (RKS-1, RKS-2, RKS-3) were drilled on eastern limb and lies on same strike continuity of Jhiri Formation, borehole spacing is 4 km. 02 nos. of boreholes (RKS-5 and RKS-9) drilled on western limb of syncline and lies on same strike continuity, which is 3.65 km apart. 02 nos. of borehole RKS-7 and RKS-8 drilled in Taragarh Formation and lies on same strike continuity, which is 5.5 km apart. 02 nos. of boreholes RKS-4 and RKS-6 were drilled in Panna Formation and lies at 3.1 km apart. The mineralized zones of borehole RKS-1, 2 & 3 were correlated. The zones

of borehole RKS-5 & 9 were also correlated. The correlations diagram of boreholes are shown in plate-7.

9.6 Description of zones:

The zone is defined by mineralized part having equal or more than 2 m width and with K_2O concentration more than or equal to a cut off of 4.5% K_2O .

9.7 Assumptions for ore resource estimation:

For resource estimation, the zone geometry and correlation along dip and strike were considered on the basis of at least two positive intersections as far as possible. The following formula is being used for the purpose of resource estimation:

In CS method: Resource = Strike length x Dip length x Thickness (true thickness) x tonnage factor (specific gravity)

9.8 Ore resource estimation by cross section method:

For the evaluation of potash bearing glauconitic sandstone/shale an attempt has been made to calculate reconnaissance resource on UNFC G-4 stage. Based on the presence of glauconitic shale thickness of individual scout boreholes and thickness of lenses in large scale mapped area were considered for resource estimation.

The following assumptions have been made for the resource estimation.

- 1. The ore resources have been calculated at 4.5% K₂O cut off.
- 2. Since, the accurate RL of the area is not available to know dip length, for resource estimation the dip length of each zone is taken as 50 m.
- 3. Strike length: Influence of individual borehole is intersected to maximum of half the distance be taken two consecutive borehole, for the correlated borehole, the strike influence is the exposed strike length, it is less than the half the distance with the adjoining borehole.
- 4. The zones equal to and above 4.5% K₂O have only been considered for calculation of resources.
- 5. Minimum 2.0 m stoping width has been considered for estimation of ore resource. Zone below stoping width have not been included for calculation of ore resource.
- 6. The specific gravity has been taken as 2.50 for the purpose of calculation of ore resources.

Details of assumptions considered for calculation of reconnaissance reserve of K₂O in each boreholes is given in annexure-27.

9.8.1 Ore Resources:

Using above criteria and assumptions a reconnaissance mineral resource of K_2O has been calculated by cross section method considering 08 nos. of scout boreholes and is shown in annexure-27. The total calculated reconnaissance resource is 57.54 Million tones with 5.30% average grade of K_2O .

9.9 Category of resource as per UNFC classification:

Report is in compliance with G-4 stage of UNFC. A reconnaissance mineral resource of 38.38 million tones has been estimated and hence report has been codified as 334.



CHAPTER-10

RECOMMENDATION

The geological and geochemical investigation has established the potash mineralization in glauconitic shale/sandstone in rocks of Sapotra- Karauli sub-basin of Vindhyan Supergroup. The study reveals that potash mineralization is mainly confined to glauconite bearing olive shale of Panna, Jhiri and Taragarh Formations. On the basis of exposure of glauconitic shale, bed rock samples and analytical result of core samples, a total 08 nos. of glauconite bearing shale zones has been delineated. These zones has been marked as PMZ-I, PMZ-II, PM-III & PMZ-IV in Panna Formation, JMZ-I, JMZ-II & JMZ-III in Jhiri Formation and TMZ-I in Taragarh Formation. The appreciable zones of potash bearing glauconitic rocks has been demarcated first time in Sapotar-Karauli sub-basin of Vindhyan Supergroup, which opens a new vista for further investigation of potash bearing glauconitic shale/sandstone in rocks of Vindhyan Supergroup.

On the basis of investigation the following recommendations are made:

- 1. A total 08 nos. of glauconite bearing mineralized zones has been demarcated, it is recommended to carry out further investigation (G3 stage) in the glauconite bearing potash mineralized zones to assess the potentiality of the zones.
- 2. Preliminary investigation (G4 stage) of potash in glauconitic shale/sandstone of Vindhyan Supergroup can be taken in following areas on the basis of exposure of glauconitic shale/sandstone followed by promising analytical results, which is as follows
 - Khaidarpur and Bhartun area: Glauconite bearing Panna shale is exposed in western extension of the present study area, (toposheet no. 54B/11). The analytical result of bed rocks samples (L-24) shows appreciable concentration of K₂O (4.95%).
 - Kotah and Mach area: Glauconite bearing Jhiri shale is exposed in northern extension of the study area (toposheet no. 54B/15). The analytical result of bed rocks sample (L-58) shows appreciable concentration of K₂O (5.34%).

- Karanpur area: Glauconite bearing Sirbu shale is exposed in toposheet no. 54B/16. The analytical result of bed rocks sample (L-88) shows appreciable concentration of K₂O (4%).
- 3. The glauconitic shale/sandstone having more than 5% of K_2O concentration can be directly used in acidic soil to enhance the soil fertility.



CHAPTER-11

CONCLUSION

A preliminary, G-4 stage mineral investigation has been carried out for the search of potash in glauconitic sandstone/shale of Sapotra-Karauli sub-basin of Vindhyan Supergroup. The present investigation comprises aerial photo interpretation of 400 Sq. km to understand the regional geology on 1:50,000 scale, Large Scale Mapping of 150 Sq. km area on 1:12,500 scale, petrological study, bed rock sampling (323 nos.), pitting/trenching (80 nos.) and 09 nos. of shallow scout borehole drilling (total 300 m). As per the nature and quantum of works all the targets has been achieved. The study area is located in Survey of India toposheet no. 54B/11, 12 and 15, covering parts of Sawai Madhopur and Karauli districts, Rajasthan.

The objective was to search and delineate glauconitic sandstone/shale in Sapotra-Karauli sub basin of Vindhyan Supergroup. The large scale geological mapping area extends from Sapotra in southwest to Mahauli in northeast, over a strike length of 26 km parallel to regional strike i.e. NE-SW. The LSM area is bounded by coordinate A -26°26′00" - 76°50′ 57", B- 26°26′00" - 76°57′ 57", C- 26°15′00" - 76°47′ 30" and D- 26°17′30" - 76°42′ 30". As outcome of large scale geological mapping, potash bearing glauconitic sandstone/shale bands have been delineated in rocks of lower part of Tirohan Limestone Formation, Panna Formation, Jhiri Formation and Taragarh Formation. In the study area, occurrence of glauconitic sandstone has been reported for the first time from Garain, Ramapura, Mohanpura and Mahauli areas. Glauconite bearing olive green to yellowish green shale bands have been delineated of appreciable length in Panna and Jhiri Formations.

Field evidences and petrological studies of surface and sub-surface samples show glauconite bearing shale horizons which occurs as bands. In shale of Panna and Jhiri Formations, the glauconite is fine to medium grained and occurs as thin laminations. In sandstone, glauconite occurs as disseminations and patches which is of detrital origin. Field evidence indicates that the concentration of glauconite is not persistent both laterally and along depth.

Analytical result of K₂O in bed rock sample, pitting/trenching sample and core sample is encouraging. Analytical results of 76 nos. of bed rock samples of shale of Panna Formation indicates that K₂O content ranges from 0.76 % to 7.21% with average value of 5.08%. Scout boreholes (RKS-4 & 6) were drilled in Panna shale, shows average grade of K₂O content of 5.0 % and 4.88 %; respectively. Analytical results of 194 nos. of bed rock samples of Jhiri Formation indicates that olive green to light green shale contain K₂O concentration ranging from 0.73% to 6.64% with an average value of 4.50%. Total 05 nos. of shallow scout boreholes (RKS-1, 2, 3, 5 & 9) were drilled, up to a maximum depth of 45 m in Jhiri Formation. Average grade of K₂O in core samples of these boreholes are 5.72%, 5.38%, 5.14%, 4.99% and 5.11% respectively. The K₂O content of glauconitic sandstone of Taragarh Fort Formation ranges from 2 to 3%, which is not encouraging. 02 nos. of scout borehole were drilled in Taragarh Fort Formation (RKS-7 & 8), average grade of K₂O in core samples of RKS-8 is 5.21%. Occurrence of thin bands of glauconitic sandstone is reported from Maihar Formation in quarry section near Karsai, Rajor and Atewa. The K₂O content of bed rock samples of Maihar Formation is not encouraging.

On the basis of geological mapping, analytical values of K_2O in bed rock samples and core samples; a total of 08 nos. of zones has been delineated as potential areas for potash bearing glauconitic shale. Out of that, four zones in Panna Formation, three zones in Jhiri Formation and one zone in Taragarh Formation has been delineated. In all these areas olive to light green glauconite bearing shale is exposed. Details of delineated zones in the area are given below:

(a) Panna Mineralized Zones (PMZ)

- 1. PMZ-I: Olive to yellowish green shale near Kaontipura having strike continuity of about 1.5 Km.
- 2. PMZ-II: Olive to yellowish green shale near Bapoti having strike continuity of 0.7 km.
- 3. PMZ-III: Olive to yellowish green shale, 1 km east of Kodai, having strike continuity of 1.0 Km.
- 4. PMZ-IV: Olive to yellowish green shale near Mahauli, having strike continuity of 1 Km.

(b) Jhiri Mineralized Zones (JMZ)

- 1. JMZ-1: Olive to yellowish green shale from Adadungar to Ramapura Ghati, having strike continuity of about 10 Km.
- 2. JMZ-II: Olive to yellowish green shale from Gothra to Garain having strike continuity of about 3.0 Km.
- 3. JMZ-III: Olive to yellowish green shale near Bajna having strike continuity of about 2.5 Km.

(c) Taragarh Mineralized Zones (JMZ)

1. TMZ-1: Olive to yellowish green shale, having strike continuity of 1 km, near Langarapura.

The resource of potash has been calculated on the basis of analytical results of core samples and bed rock samples of glauconitic shale/sandstone. Resource has been calculated by cross section method, assuming cut off grade 4.5% of K_2O . The calculated reconnaissance resource of K_2O in the study area is 57.45 Million tones with average grade of 5.30% K_2O , which is encouraging.

On the basis of investigation, areas have been delineated for further G3 stage potash exploration and new areas has been recommended for G4 stage of potash investigation. The present investigation reveals first time occurrences of appreciable zones of potash bearing glauconitic rocks with encouraging K₂O% in Sapotra-Karauli sub-basin of Vindhyan Supergroup. It will open a new vista for further investigation of potash bearing glauconitic shale/sandstone in rocks of Vindhyan Supergroup.

REFERENCE

- Dutta, Singh, Sinha., (1974-1977): Report on the Geology of Noroli, Karauli, Hindaun-Masalpar area of Bharatpur- and Sawai Madhopur districts, Rajasthan. Unpublished GSI report for F.S. 1974-75.
- Heron, (1917): The geology of north-eastern Rajputhana and adjacent districts, Mem. Geol. Surv. Ind. (45).
- Heron.,: The Gwalior and Vindyan systems in south-eastern Rajputhana, Mem. Geol. Surv. Ind. (45)
- Indian Minerals Yearbook 2014, Part-III: Mineral Reviews-53rd Edition, Potash.
- Kumar, Virender and Bakliwal, P.C., (2005): Potash in India, Miscellaneous Publication no.65, GSI, WR, Jaipur.
- Maharaja Singh H.J. and Mehta P.N. (1977): A report on the geology of Gunesheri-Sapotra-Gangapur-Kailadevi areas of Sawai Madhopur district, Rajasthan. Unpublished Prog. Rep. for FS: 1975-76.
- Maharaja Singh and H.J., Sinha., (1976): A Report on the geology of Guneshri Sapotra Gangapur-Kailadevi areas of Sawai Mahopur district, Rajasthan, Unpublished GSI report for F.S. 1975-76.
- Medlicott, H.B., (1868): The boundary of Vindhyan Series in Rajputhana. Rec. Geol. Surv. Ind. 1(3).
- Mehrotra, M.N. and Bhattacharya, B.B., (1975): A study of Vindhyan glauconitic sandstone formation of Son Valley district Sidhi, India XIIth international Congress, Sedimentology, Nice. France, Theme 10; 63-72.
- Petti John, F. J., Potter, P. E. and Siever, R., (1972): Sand and sandstone. Springler-Verlad, Berlin.
- Richard C. Selley.,: Applied Sedimentology, 1988, p. 294.
- Sahu R.L. (1994): A report on the geology of Vindhyan Supergroup of southeastern Rajasthan. Unpublished Final Rep. for FS: 1992-93.
- Sahu, R.L., (1994): Final report on the geology of Vindhyan Supergroup of south-eastern Rajasthan (Dec, 1994).

- Sant, V. N., Chakraborty D. K., Saxena S. P., Chakraborty, B. and Singh G. B. (1968): A report on the traverses taken in search of phosphorite in Chittorgarh area, district Chittorgarh, Rajasthan. Unpublished Prog. Rep. for FS: 1968-69.
- Sinha., (1975):. A report on Systematic geological mapping in Bharatpur, Rupbas area, Bharatpur & Alwar Distt:, Rajasthan. Unpublished GSI Report for F.S.
- Vinogradov, A. P., Tugarinov, A. I., Zikhov, C. I., Stanikova, N. I., Bibikova, E. V. and Khorre, K. (1964): Geochronology of Indian Precambrian; Report 22nd IGC New Delhi 10553–567.



LOCALITY INDEX

Sl.No.	Village	Latitude	Longitude
1	Adadungar	26°17'52"	76°47'26.9"
2	Alampura	26°24'46"	76°53'17.9"
3	Amargarh	26°15'34"	76°45'9.9"
4	Amarwar	26°17'59"	76°50'17.8"
5	Atewa	26°23'11"	76°55'56.2"
6	Bajna	26°17'16"	76°46'36"
7	Bajne ka Pura	26°23'36"	76°54'21.3"
8	Baniya Khora	26°18'54"	76°49'4.5"
9	Bapoti	26°18'15"	76°43'31.7"
10	Bariya	26°28'30"	76°51'30"
11	Barriya	26°25'26"	76°52'11"
12	Bawali	26°25'0"	76°55'26.6"
13	Bharatpur	27°13'03"	77°29'20"
14	Bhatpura	26°21'55"	76°52'13.7"
15	Bhilwara	26°20'40"	74°37'52"
16	Bhuri Pahari	26°11'42.7"	76°35'39.9"
17	Bichpanya	26°22'9"	76°52'32.1"
18	Bilkaoh	26°17'55"	76°44'48"
19	Bundi	25°37'0"	75°39'0"
20	Chhipghata	26°23'34"	76°55'12.2"
21	Chittorgarh	21°53'0"	77°38'0"
22	Dholpur	26°42'13"	77°53'36"
23	Dudrai	26°17'47"	76°48'3"
24	Dudupura	26°21'14.17"	76°51'22.0"
25	Dungri	26°09'16.2"	76°35'58.9"
26	Gangapur	26°28'22"	76°43'26"
27	Gangurda	26°21'24"	76°50'40"
28	Garain	26°20'48"	76°48'49"
29	Gorahar	26°22'19"	76°53'12"
30	Gothra	26°18'52"	76°47'32"
31	Hariya ka Mandir	26°20'46"	76°46'15"
32	Jhalawar	24°35'52"	76°09'38"
33	Jirota	26°17'46.8"	76°38'57"
34	Kaila Devi	26°20'9"	76°53'35"
35	Kanapura	26°21'17"	76°46'40"
36	Kaontipura	26°16'55"	76°44'36"
37	Karauli	26°29'48"	77°1'24"
38	Karsai	26°25'29"	76°57'1"

Sl.No.	Village	Latitude	Longitude
39	Khaoda	26°17'48"	76°43'37"
40	Kodai	26°20'30"	76°46'55"
41	Kota	26°12'48"	75°51'46"
42	Kotah	26°26'53"	76°55'38"
43	Langarapura	26°23'58"	76°52'20"
44	Mach	26°27'40"	76°55'52"
46	Mahauli	26°25'39"	76°24'38"
47	Mandwara	26°25'57.8"	76°51'5.03"
48	Manoharpura	26°22'49"	76°51'56"
49	Mijhaura	26°17'43"	76°47'1"
50	Narayanpur Tatwra	26°21'26"	76°38'31"
52	Nishana	26°16'22"	76°43'38"
53	Pitupura	26°20'36.3"	76°50'52.6"
54	Rajor	26°24'15"	76°56'34"
55	Ramapura	26°22'56"	76°53'14"
56	Ramapura Ghati	26°22'56"	76°53'13.8"
57	Saimarda	26°22'41"	76°50'3"
58	Sapotra	26°17'29"	76°45'8"
59	Sawai Madhopur	26°1'3"	76°21'15"
60	Shyampura	26°08'45.7"	76°30'42.31"
61	Suratpura	26°19'18"	76°45'48"
62	Thulwari	26°16'30"	76°42'40"
63	Tursangpura.	26°18'32"	76°44'48"

Geochemical analytical results of Bed Rock Samples of Tirohan Limestone Formation

S.No	Sample	Latitude	Longitude	Lithology	SiO ₂	Al_2O_3	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	TiO ₂	P_2O_5
	ID				(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	S-40	26°18'6.3"	76°39'46"	Limestone	1.17	0.25	1.47	0.06	18.38	36.90	0.01	0.08	0.02	0.01
2	M-212	26°21'45.4"	76°46'53.3"	Limestone (tube well)	27.38	5.06	2.51	0.07	14.31	21.84	0.15	0.81	0.84	0.01
3	M -441	26°23'57.9"	76°54'48.1"	Glauconitic Sandstone	85.43	4.78	2.94	0.31	1.11	0.01	1.74	0.04	0.84	0.07
4	M -446	26°23'32.8"	76°54'35.4"	Glauconitic Sandstone	84.44	1.48	1.02	4.91	1.13	0.01	0.89	0.05	0.84	0.15
5	M -447	26°23'31.3"	76°54'33.8"	Glauconitic Sandstone	90.14	3.14	1.09	0.34	0.62	0.01	0.99	0.01	0.84	0.04
6	M -627	26°23'53.9"	76°54'47.2"	Limestone	26.01	5.86	4.86	23.72	10.76	0.04	2.58	0.16	0.84	0.02
7	M-635	26°18'52.8"	76°44'42.5"	Limestone	10.10	2.21	1.63	35.31	12.28	0.02	0.44	0.07	0.84	0.01
8	M-641	26°18'5.8"	76°44'14.4"	Limestone	94.09	1.33	0.53	0.18	0.07	0.01	0.11	0.01	0.84	0.01

Geochemical analytical results of Bed Rock Samples of Tirohan Conglomerate Formation

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
1	S-36	26°17'47.3"	76°43'57.2"	Clay (Mine)	63.37	21.64	2.61	0.01	0.90	0.51	0.01	4.40	0.83	0.03
2	S-38	26°14'36.2"	76°42'35.3"	Iron nodules	51.50	12.04	27.38	0.03	0.59	0.44	0.01	1.52	0.44	0.06
3	S-39	26°14'19.5"	76°40'21.7"	Banded Iron	40.24	3.30	47.35	1.32	0.15	0.09	0.01	0.72	0.12	0.02
4	M-240	26°16'1.9"	76°45'54.4"	Breccia	97.38	0.97	0.25	0.01	0.00	0.10	0.00	0.11	0.84	0.04
5	M -445	26°23'43.6"	76°54'46.3"	Breccia	89.37	2.89	1.84	0.37	0.91	0.00	1.28	0.01	0.84	0.11
6	M -626	26°23'53.9"	76°54'47.5"	Breccia	95.26	1.54	0.32	0.55	0.07	0.01	0.05	0.01	0.84	0.04
7	M-636	26°18'52.8"	76°44'42.5"	Banded Iron	21.11	7.58	60.29	3.28	0.72	0.03	0.94	1.12	0.84	0.02
8	M-637	26°18'38.8"	76°44'34.2"	Clay (Mine)	68.06	20.46	1.81	0.21	1.60	0.20	4.72	0.02	0.84	0.06
9	M-638	26°18'38.8"	76°44'34.2"	Clay (Mine)	77.48	14.33	1.19	0.35	1.06	0.10	2.86	0.02	0.84	0.04
10	M-639	26°18'27.3"	76°44'27.5"	Clay (Mine)	74.87	16.36	2.69	0.59	0.90	0.06	1.53	0.01	0.84	0.05

Geochemical analytical results of Bed Rock Samples collected from Chittorgarh Formation

Annexure-3

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
1	M-208	26°19'34.6"	76°46'5.1"	Sandstone	55.37	21.66	6.32	0.03	1.67	4.59	0.10	4.70	0.84	0.05

Geochemical analytical results of Bed Rock Samples collected from Panna Formation

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
1	S-33	26°22'57.5"	76°54'2.2"	Light green shale	52.45	21.54	4.73	0.06	1.23	3.13	0.12	5.19	0.85	0.07
2		26°25'50.9"	76°55'4.2"	Shale	68.84	13.03	5.23	0.06	1.89	2.22	0.23	3.89	0.7	0.12
3	S-41	26°17'7.1"	76°44'24.4"	Khaki Shale	51.27	22.62	4.72	0.03	1.43	4.57	0.06	4.95	0.84	0.07
4	L-88	26°11'24.1"	76°58'10.8"	Light green shale	70.47	15.3	5.56	0.06	1.45	0.27	0.02	3.79	0.81	0.07
5	PS-1A	26°18'15.2"	76°45'37.7"	Shale mixed khaki and red shale	61.29	23.93	4.45	0.02	1.62	0.43	0.19	5.6	0.75	0.06
6	PS-1B	26°18'15.2"	76°45'37.7"	Shale mixed khaki and red shale	57.75	23.99	6.92	0.02	1.77	0.18	0.2	5.85	0.9	0.07
7	PS-1C	26°18'15.2"	76°45'37.7"	Shale mixed khaki and red shale	60.35	26.06	2.77	0.02	1.84	0.33	0.13	6.19	1.01	0.08
8	PS-1D	26°18'15.2"	76°45'37.7"	Shale mixed khaki and red shale	57.89	26.3	5.61	0.03	1.89	0.33	0.14	6.35	0.96	0.08
9	PS-1E	26°18'15.2"	76°45'37.7"	Shale mixed khaki and red shale	56.87	27.86	4.88	0.01	1.78	0.19	0.27	6.76	1.02	0.07
10	PS-2	26°18'17.9"	76°45'38.9"	Shale yellowish green	48.77	18.05	4.73	0.04	1.7	14.01	0.08	4	0.53	0.03
11	PS-3	26°18'20.2"	76°45'40.4"	Shale yellowish green	59.29	22.05	7.05	0.04	2.09	3	0.33	4.83	0.8	0.06
12	PS-4	26°18'22"	76°45'44.1"	Shale yellowish green	54.65	21.91	4.71	0.02	1.69	9.07	0.08	4.2	0.67	0.05
13	PS-5A	26°18'31.6"	76°45'50.8"	Shale yellowish green	58.07	24.6	6.45	0.03	1.84	0.52	0.18	5.2	0.87	0.07
14	PS-5B	26°18'32.4"	76°45'49.4"	Shale yellow	57.3	17.29	4.51	0.06	1.31	11.95	0.17	3.15	0.5	0.04
15	PS-5C	26°20'49.5"	76°47'35"	Shale yellowish green	52.27	18.57	7.15	0.07	1.31	12.98	0.01	3.5	0.67	0.05
16	PS-6	26°20'48.6"	76°47'37"	Shale yellowish green	52.83	20.47	6.73	0.06	1.27	6.41	0.01	4.41	0.72	0.08
17	PS-7	26°20'31.5"	76°47'30.9"	Shale yellowish green	54.68	19.15	5.34	0.06	1.23	5.23	0.01	4.7	0.75	0.06
18	PS-8	26°20'53.3"	76°47'38.8"	Shale yellow	45.49	13.71	4.29	0.03	1.05	24.08	0.07	2.28	0.51	0.05
19	PS-9	26°20'54.9"	76°47'40.9"	Shale yellowish green	54.74	19.74	5.24	0.02	1.2	11.16	0.01	4.11	0.69	0.06
20	PS-10	26°20'56.4"	76°47'42.5"	Shale yellowish green	49.28	19.74	6.15	0.03	1.89	10.24	0.19	3.91	0.71	0.05
21	PS-11A	26°17'10.3"	76°45'3.5"	Shale yellowish green	57.28	24.38	8.01	0.05	1.64	0.79	0.17	5.64	0.85	0.08
22	PS-11B	26°17'10.3"	76°45'3.5"	Shale yellowish green	61.05	24.86	4.99	0.05	1.68	0.34	0.1	6	0.85	0.07
23	PS-12	26°17'7.4"	76°44'58.5"	Shale yellowish green	57.03	24.07	7.89	0.04	1.86	1.59	0.13	5.17	0.88	0.07
24	PS-13A	26°17'0.5"	76°44'58"	Shale yellowish green	61.01	23.97	6.71	0.04	1.76	0.32	0.14	5.68	0.87	0.06
25	PS-13B	26°17'1.2"	76°44'56.9"	Shale yellowish green	60.01	22.51	6.33	0.05	1.91	3	0.12	5.09	0.76	0.06
26	PS-14A	26°16'53.8"	76°45'2.1"	Shale yellowish green	57.58	25.01	7.76	0.04	2.06	0.54	0.14	5.42	0.9	0.07
27	PS-14B	26°16'52.8"	76°45'0.2"	Shale red	62.61	22.57	5.15	0.01	2.25	0.23	0.09	5.14	0.81	0.06
28	PS-15	26°16'50.2"	76°45'3.5"	Shale yellow	53.4	20.17	5.8	0.04	1.72	8.57	0.08	3.9	0.65	0.04
29	PS-16A	26°16'49.4"	76°45'16.5"	Shale yellow	45.41	20.56	2.93	0.01	0.9	16.08	0.05	2.09	0.68	0.04
30	PS-16B	26°16'51"	76°45'10.8"	Shale yellow	48.3	21.49	6.38	0.03	1.82	10	0.08	4.1	0.69	0.05
31	PS-17A	26°16'46.3"	76°45'21.9"	Shale yellowish green	57.96	23.19	8.6	0.05	1.97	1.52	0.1	5.19	0.87	0.07
32	PS-17B	26°16'46.8"	76°45'21.4"	Shale yellowish green	57.64	21.02	7.23	0.06	1.64	3.88	0.09	5.09	0.84	0.07
33	PS-17C	26°16'45"	76°45'18.2"	Shale yellowish green	60.59	24.13	6.4	0.03	2.06	0.16	0.09	5.53	0.78	0.07
34	PS-17D	26°16'44.8"	76°45'17.8"	Shale yellowish green	58.38	24.3	7.76	0.05	1.94	0.58	0.11	5.55	0.88	0.07
35	PS-17E	26°16'47.1"	76°45'12.2"	Shale yellowish green/siltstone	63.91	23.17	4.97	0.03	1.69	0.29	0.11	5.2	0.78	0.05
36	PS-17F	26°16'45.9"	76°45'9"	Shale yellowish green/siltstone	74	18.84	0.87	0	1.19	0.15	0.08	3.92	0.59	0.04
37	PS-18A	26°16'46.3"	76°45'25.2"	Shale yellowish green	56.35	24.14	4.05	0.03	1.72	2.41	0.21	5.33	0.96	0.07
38	PS-18B	26°16'38.9"	76°45'23.9"	Shale yellowish green	57.83	22.73	6.82	0.03	1.88	2.28	0.38	4.97	0.83	0.06

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
39	PS-19	26°17'9.1"	76°44'54.7"	Shale yellowish green	51.67	22.82	7.85	0.05	2.07	6.06	0.09	4.92	0.86	0.06
40	PS-20	26°17'9.8"	76°44'52.3"	Shale yellowish green	60.41	24.69	6.18	0.02	1.72	0.4	0.1	6	0.92	0.07
41	PS-22A	26°17'9.9"	76°44'46.3"	Shale yellowish green	60.72	22.62	5.34	0.01	1.47	0.32	0.09	5.45	0.83	0.07
42	PS-22B	26°17'8.9"	76°44'46.5"	Shale yellowish green	57.45	23.13	8.72	0.04	2.08	0.39	0.09	5.21	0.82	0.06
43	PS-23	26°17'0.1"	76°44'36.4"	Shale yellowish green	90.97	5.37	0.21	0	0.21	0.08	0.01	0.76	0.21	0.02
44	PS-24	26°20'59"	76°52'29.3"	Dug well sample	66.48	19.43	4.11	0.16	1.71	0.38	0.08	3 4.9	0.7	0.05
45	PS-25	26°21'2.6"	76°52'32.9"	Shale yellowish green	67.08	18.5	4.64	0.09	1.66	0.31	0.07	4.79	0.64	0.06
46	PS-26	26°21'57.8"	76°53'16.7"	Shale yellowish green/maroon	55.3	22.12	5.59	0.03	1.75	3.09	0.09	5.41	0.87	0.05
47	PS-27	26°22'0.9"	76°53'20.1"	Shale maroon	58.95	20.56	6.95	0.03	2.31	1.22	0.08	4.81	0.7	0.05
48	PS-28	26°22'6.6"	76°53'24.1"	Shale green/maroon	59.45	20.41	7.32	0.03	2.56	0.96	0.07	4.67	0.76	0.05
49	PS-29	26°22'52.5"	76°54'4.6"	Shale red (dug well sample)	59.11	22.3	6.21	0.02	2.2	0.42	0.09	5.61	0.89	0.06
50	PS-30	26°22'57.2"	76°54'1.8"	Shale yellowish green	58.92	21.89	3.43	0.02	1.61	2.65	0.27	5.33	0.91	0.07
51	PS-31	26°23'43.2"	76°54'6.5"	Shale yellowish green	57.17	23.48	3.19	0.02	1.71	3.09	0.09	5.48	0.9	0.06
52	PS-32	26°23'46.6"	76°54'9.3"	Shale red/light green	50.55	23.08	3.38	0.03	1.74	6.69	0.08	5.63	0.99	0.07
53	PS-33	26°24'19.5"	76°54'17.8"	Shale ferruginous	59.58	22.41	1.18	0.02	0.98	5.87	0.07	3.19	0.77	0.04
54	PS-34	26°25'26.8"	76°54'29.5"	Shale maroon	61.07	21.01	5.81	0.04	2.29	0.46	0.07	5.84	0.78	0.05
55	PS-35	26°25'30"	76°54'33.2"	Shale maroon	62.12	23.51	2.38	0.03	1.82	0.26	0.09	6.36	0.96	0.07
56	PS-36	26°25'23.3"	76°54'37.1"	Sandstone/shale glauconitic	53.75	22.49	4.42	0.02	3.51	2.18	0.09	7.21	1.59	0.04
57	PS-37	26°25'32.7"	76°54'35.4"	Shale yellowish green	60.18	20.93	6.46	0.08	1.43	0.93	0.06	5.4	0.8	0.06
58	PS-38	26°25'4.7"	76°54'17"	Shale brown to yellowDug well sample	62.96	22.82	3.99	0.05	1.58	0.26	0.07	5.34	0.81	0.05
59	PS-39A	26°25'26.5"	76°54'29.3"	Shale brown to greenish	60.69	19.95	6.05	0.06	1.94	0.44	0.08	5.4	0.74	0.06
60	PS-39B	26°25'26.5"	76°54'29.3"	Shale brown to greenish	61.08	19.49	7.13	0.07	1.93	0.84	0.07	5.25	0.69	0.05
61	PS-39C	26°25'26.5"	76°54'29.3"	Shale brown to greenish	60.82	21.52	6	0.04	2.32	0.39	0.08	5.85	0.88	0.06
62	PS-39D	26°25'26.5"	76°54'29.3"	Shale brown to greenish	60.7	20.61	7.03	0.04	2.28	0.45	0.07	5.51	0.76	0.05
63	PS-39E	26°25'26.5"	76°54'29.3"	Shale brown to greenish	61.13	21.18	5.79	0.04	2.31	0.42	0.08	5.76	0.8	0.06
64	PS-39F	26°25'26.5"	76°54'29.3"	Shale brown to greenish	61.16	22.02	5	0.03	2.26	0.38	0.07	6.1	0.81	0.05
65	PS-40A	26°25'27.7"	76°54'28.5"	Shale brown to greenish	60.92	21.83	5.9	0.03	2.21	0.37	0.08	5.92	0.81	0.06
66	PS-40B	26°25'27.7"	76°54'28.5"	Shale brown to greenish	59.43	22.95	5.06	0.02	2.3	0.38	0.08	6.16	0.93	0.06
67	PS-40C	26°25'27.7"	76°54'28.5"	Shale brown to greenish	62.93	21.23	4.18	0.03	2.04	0.4	0.08	5.73	0.76	0.05
68	PS-41	26°25'27.7"	76°54'26.5"	Shale brwon to yellow	62.6	20.01	5.16	0.05	1.99	0.22	0.07	5.62	0.68	0.05
69	PS-42A	26°25'30.5"	76°54'33"	Shale brwon to yellow	58.19	21.89	5.46	0.09	1.42	3.28	0.07	4.98	0.8	0.06
70	PS-42B	26°25'30.5"	76°54'33"	Shale brwon to yellow	60.8	21.31	6	0.03	2.42	0.32	0.07	5.85	0.81	0.05
71	PS-43A	26°25'30.5"	76°54'33"	Shale brwon to yellow	60.23	22.22	4.94	0.11	1.45	1.33	0.07	5.33	0.8	0.06
72	PS-43B	26°25'30.5"	76°54'33"	Shale brwon to yellow	62.2	21.09	4.53	0.08	1.41	0.83	0.06	5.61	0.79	0.06
73	PS-43C	26°25'30.5"		Shale brwon to yellow	60.61	23.99	2.53	0.04	1.75	0.24	0.08	6.42	0.95	0.07
74	PS-44A	26°25'30.7"	76°54'34.3"	Shale greenish to brown	61.65	22.05	5.64	0.11	1.46	0.3	0.07	5.31	0.74	0.06
75	PS-44B	26°25'30.7"	76°54'34.3"	Shale greenish to brown	64.38	21.01	5.31	0.11	1.38	0.24	0.06	5.1	0.68	0.05
76	PS-45	26°25'34.2"	76°54'35.3"	Shale brownish green	60.61	23.96	4.01	0.05	1.64	0.38	0.08	6.29	0.87	0.06

Geochemical analytical results of Bed Rock Samples of Indergarh Formation.

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	TiO ₂	P_2O_5
				33	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	S-24	26°18'11.9"	76°45'40.7"	Sandstone (grey)	69.92	19.01	0.75	< 0.01	0.56	0.15	< 0.01	4.15	0.51	0.03
2	M-217	26°20'47.7"	76°47'38.8"	Sandstone	88.4	9.06	0.2	0	0.15	0.1	0.01	0.39	0.84	0.03
3	M-223	26°17'45.8"	76°45'39.6"	Light green Sandstone	94.77	1.45	0.22	0.01	0.13	0.14	0.05	0.14	0.84	0.04
4	M-226	26°17'26.6"	76°44'53.6"	Micaceous Sandstone (tube well)	61.69	21.49	6.37	0.06	2.47	0.13	0.1	4.98	0.84	0.07
5	M -417	26°25'25.9"	76°54'43.8"	Sandstone	88.55	5.11	0.93	0.14	0.38	0.05	2.25	0	0.84	0.02
6	M -624	26°25'30.9"	76°54'35.8"	Sandstone	88.89	5.71	0.49	0.03	0.21	nd	1.01	nd	0.84	0.01
7	S-23	26°18'16"	76°45'38.9"	Clay	58.03	23.05	4.45	0.01	1.11	0.22	0.14	5.65	0.85	0.05
8	S-42	26°16'44.2"	76°45'8.8"	Clay	61.44	24.44	0.77	< 0.01	0.53	0.23	< 0.01	2.97	1.49	0.1
9	M-234	26°16'45.8"	76°45'12.6"	Clay	64.45	27.59	1.84	0	0.58	0.08	0.12	2.14	0.84	0.09
10	M-245	26°16'59.7"	76°44'20"	Clay	60.31	27.44	5.61	0.01	0.74	0.06	0.07	2.73	0.84	0.07

S.No	Sample II	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%	MgO (%	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
1	S-20	26°16'55.5"	76°47'0.1"	Khaki Shale	55.73	19.12	9.53	0.06	1.37	1.72	0.14	4.05	0.84	0.08
2	S-21	26°17'3.2"	76°47'12"	Khaki Shale	57.26	19.72	8.34	0.04	1.49	0.38	0.02	4.96	1.13	0.05
3	S-25	26°20'54.1"	76°48'34.3"	Olive shale	60.28	19.38	5.9	0.02	1.31	0.4	0.07	4.74	0.9	0.04
4	S-28	26°18'47.4"	76°49'4.5"	Olive shale	57.12	19.65	6.35	0.03	1.61	0.69	0.005	5.81	0.89	0.04
5	S-29	26°19'35.7"	76°50'9.9"	Olive green shale	51.94	18.44	6.81	0.03	1.68	4.73	0.005	4.69	0.86	0.06
6	S-30	26°20'56.6"	76°50'58.8"	Light green shale	52.24	19.21	6.92	0.06	1.75	2.64	0.005	5.72	0.81	0.04
7	S-31	26°21'40.4"	76°51'57.2"	Light green shale	58.11	17.85	7.45	0.04	1.46	0.56	0.005	4.94	0.84	0.07
8	S-35	26°26'58.5"	76°54'41.8"	Shale	54.09	20.11	7.46	0.02	1.71	1.17	0.005	5.34	0.91	0.04
9	M-45	26°22'26.1"	76°49'32"	Khaki green shale	64.71	17.18	5.26	0.03	1.45	1.49	0.005	4.95	0.86	0.08
10	M-51	26°17'14.2"	76°46'28.2"	Light green shale	63.78	18	5.9	0.05	1.4	0.33	0.005	5.48	1.3	0.07
11	M-64	26°17'3.5"	76°47'20.3"	Light green shale	61.13	18.24	6.57	0.03	1.76	2.31	0.005	5.37	1.26	0.06
12	M-67	26°17'26.8"	76°47'51.4"	Light green shale	61.59	18.77	6.81	0.02	1.67	0.53	0.005	5.7	1.27	0.07
13	M-83	26°19'0.5"	76°49'7.2"	Light green shale	55.16	20.16	6	0.02	1.51	5.84	0.005	5.19	0.88	0.07
14	M-96	26°19'38.1"	76°50'22.9"	Light green shale	58.34	19.49	6.77	0.02	1.95	2.92	0.005	6.21	0.88	0.05
15	M-99	26°21'13.6"	76°51'10.9"	Light green shale	92.75	2.41	1	0.01	0.43	0.09	0.005	0.73	0.07	0.1
17	M-165	26°21'32.2"	76°51'42.1"	Olive Shale	65.98	16.39	4.74	0.04	1.52	1.3	0.02	5.15	0.84	0.05
19	JS-1	26°17'53.5"	76°48'6.5"	Shale, yellow	62.55	19.29	5.66	0.02	1.87	0.46	0.09	4.49	1.37	0.06
20	JS-2	26°18'11.3"	76°48'19.1"	yellow shale &sandstone	57.58	19.11	5.62	0.03	1.68	5.12	0.09	3.55	1.19	0.13
22	JS-4A	26°18'47.5"	76°49'4.7"	Shale olive	59.69	21.68	5.82	0.02	2.24	0.48	0.08	5.91	0.99	0.07
23	JS-4B	26°18'47.5"	76°49'4.7"	Shale marrown	58.33	20.81	8.11	0.07	2.07	0.71	0.08	5.49	0.9	0.06
24	JS-5	26°18'54.9"	76°49'50"	Shale olive	58.52	21.48	6.47	0.04	2.07	2.2	0.08	5.62	0.87	0.07
25	JS-6	26°19'6.8"	76°49'57.2"	Varigated shale	50.41	20.48	6.79	0.05	2.13	7.49	0.08	5.59	0.83	0.07
26	JS-7	26°19'33.1"	76°50'7.9"	Varigated shale	50.81	20.63	6.85	0.02	2.11	7.23	0.09	5.19	0.82	0.05
27	JS-8	26°19'35.8"	76°50'9.1"	Shale yellowish green	52.44	20.03	6.56	0.03	2.31	6.32	0.2	4.51	0.87	0.06
28	JS-9	26°19'31.9"	76°50'19.7"	Shale yellowish green	49.82	16.54	9.23	0.1	1.64	10.06	0.07	3.45	0.84	0.1
29	JS-10	26°19'33.4"	76°50'22.8"	Shale yellowish green	52.13	19.09	6.71	0.03	2.29	7.84	0.08	4.18	1.03	0.06
30	JS-11	26°19'34.8"	76°50'22.6"	Shale yellowish green	48.7	22.19	4.25	0.02	1.61	9.94	0.16	3.9	0.85	0.06
31	JS-12	26°19'36.6"	76°50'22.1"	Shale yellowish green	50.65	21.13	6.32	0.03	1.83	7.72	0.07	4.33	0.81	0.06
32	JS-13	26°19'46.4"	76°50'28.3"	Shale yellowish green	54.85	24.46	7.88	0.03	2.25	0.67	0.11	5.21	0.98	0.08
33	JS-14	26°19'51.6"	76°50'29.9"	Shale yellowish green	57.68	20.05	6.5	0.05	1.95	3.99	0.08	4.19	1.19	0.07
34	JS-15	26°20'10.3"	76°50'40.7"	Shale yellowish green	61.91	20.98	6.24	0.03	1.73	0.56	0.08	4.05	1.34	0.07
35	JS-16	26°20'15.9"	76°50'41.8"	Shale yellowish green	60.29	22.31	5.77	0.02	1.76	0.4	0.09	4.3	1.43	0.06
36	JS-17	26°20'24"	76°50'46.3"	Shale yellowish green	60.16	20.94	7.08	0.03	2.12	0.57	0.12	5.12	1.2	0.06
37	JS-18	26°20'27"	76°50'45.9"	Shale yellowish green	59.33	21.98	7.34	0.04	2.09	0.46	0.08	4.66	1.28	0.07
38	JS-19	26°20'32.2"	76°50'49"	Shale yellowish green	61.21	20.96	6.94	0.03	2.09	0.43	0.11	5.15	1.18	0.06

S.No	Sample II	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%	/IgO (%	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
39	JS-20	26°20'29.9"	76°50'43.5"	Shale maroon	59.02	21.73	6.88	0.04	1.97	1.17	0.09	4.92	1.16	0.07
40	JS-21	26°20'30"	76°50'48.5"	Shale yellowish green	56.61	20.39	6.3	0.03	2.01	4.41	0.08	4.56	1.12	0.06
41	JS-22	26°20'41.3"	76°50'48.6"	Shale yellowish green	58.6	23.34	7.07	0.06	2.17	0.32	0.09	5.7	0.94	0.07
42	JS-23	26°20'45"	76°50'49.7"	Shale yellowish green	56.52	22.42	8.84	0.09	2.05	0.78	0.09	5.81	0.93	0.11
43	JS-24	26°20'49.3"	76°50'52.3"	Shale yellowish green	59.05	22.32	7.16	0.07	2.22	0.27	0.09	6.06	0.91	0.06
44	JS-25A	26°20'54.5"	76°50'55.3"	Shale yellowish green	59.01	22.14	7.3	0.02	2.06	0.47	0.08	5.13	0.93	0.07
45	JS-25B	26°20'54.2"	76°50'55.9"	Shale yellowish green	56.48	21.68	7.32	0.02	2.3	2.37	0.08	5.39	0.94	0.08
46	JS-25C	26°20'52.7"	76°50'56.5"	Shale yellowish green	57.87	20.99	7.67	0.07	2.35	1.94	0.17	5.4	0.88	0.06
47	JS-25D	26°20'51.8"	76°50'56.6"	Shale yellowish green	54.99	21.16	7.79	0.06	2.6	3.41	0.11	4.63	0.94	0.07
48	JS-26	26°20'58.1"	76°50'59.7"	Shale yellowish green & maroon	57.13	20.31	8.11	0.12	2.32	2.27	0.11	5.12	0.86	0.07
49	JS-27	26°21'6.2"	76°51'3.4"	Shale yellowish green	57.76	22.49	7.7	0.04	2.4	0.47	0.11	5.37	0.96	0.06
50	JS-28A	26°21'13.7"	76°51'10.8"	Shale yellowish green	59.79	20.38	7.21	0.06	2.08	1.33	0.1	5.05	1.16	0.08
51	JS-28B	26°21'12.4"	76°51'11.4"	Shale yellowish green	56.69	21.71	7.19	0.02	2.52	2.53	0.09	5.38	0.93	0.05
52	JS-29	26°21'12.8"	76°51'13"	Shale yellowish green/siltstone	59.01	22	7.35	0.03	2.33	0.35	0.1	5.8	0.94	0.06
53	JS-30A	26°21'18.8"	76°51'17.1"	Shale yellowish green	59.22	22.16	7.27	0.06	2.11	0.24	0.08	5.38	0.94	0.09
54	JS-30B	26°21'18.4"	76°51'17.4"	Shale yellowish green	61.32	20.53	6.39	0.02	2.16	0.37	0.08	5.31	0.88	0.07
55	JS-30C	26°21'18.2"	76°51'18.2"	Shale yellowish green	59.3	22.38	7.22	0.04	2.28	0.37	0.09	5.39	1	0.07
56	JS-30D	26°21'17.5"	76°51'18.3"	Shale yellowish green	57.5	21.46	7.57	0.03	2.65	2.37	0.09	5.18	0.93	0.06
57	JS-31	26°21'19.4"	76°51'21.3"	Shale yellowish green	57.17	23.73	7.61	0.02	2.42	0.46	0.09	5.35	1.02	0.07
58	JS-32	26°21'20.9"	76°51'24.7"	Shale yellowish green/siltstone	58.06	22.91	7.72	0.03	2.33	0.44	0.1	5.36	0.95	0.06
59	JS-33A	26°21'23.5"	76°51'33.3"	Shale yellowish green	60.52	22.98	6.3	0.02	2.25	0.28	0.11	5.22	1.35	0.07
60	JS-33B	26°21'23"	76°51'32.2"	Shale yellowish green	61.71	21.2	6.7	0.03	2.35	0.65	0.1	4.85	1.17	0.06
61	JS-33C	26°21'22.2"	76°51'31.2"	Shale yellowish green	59.29	23.07	7.1	0.04	2.14	0.28	0.1	5.92	0.95	0.07
62	JS-33D	26°21'21.1"	76°51'31.9"	Shale yellowish green	56.34	21.47	7.6	0.02	2.45	2.09	0.12	5.44	0.9	0.06
63	JS-33E	26°21'20.8"	76°51'32"	Shale yellowish green	52.99	21.19	5.62	0.02	2.59	5.43	0.1	5.52	0.85	0.06
64	JS-34	26°21'21.9"	76°51'36.2"	Shale yellowish green	58.84	21.63	7.16	0.06	2.37	1.29	0.08	4.96	0.94	0.09
65	JS-35	26°21'23.4"	76°51'40"	Shale yellowish green	55.88	20.57	7.09	0.05	2.39	3.94	0.09	4.24	1.07	0.05
66	JS-36	26°21'25.5"	76°51'43.6"	Shale yellowish green	52.87	14.42	7.05	0.21	1.68	10.09	0.1	2.07	0.73	0.04
67	JS-37A	26°21'37.7"	76°51'48.6"	Shale yellowish green/siltstone	61.85	22.19	5.33	0.02	1.85	0.26	0.1	5.01	1.35	0.08
68	JS-37B	26°21'32.2"	76°51'49.9"	Shale yellowish green/siltstone	60.51	20.69	6.63	0.06	2.14	1.97	0.09	5.04	1.18	0.06
70	JS-37C	26°21'33.5"	76°51'51.9"	Shale yellowish green	58.61	21.28	6.12	0.02	2.22	2.21	0.09	4.86	1.16	0.05

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71	JS-37D	26°21'37.5"	76°51'54.7"	Shale yellowish green	60.84	21.89	6.77	0.07	2.01	0.46	0.08	5.38	0.88	0.06
72	JS-37E	26°21'39.9"	76°51'56.4"	Shale yellowish green	59.51	21.99	6.76	0.03	2.22	0.96	0.13	5.38	0.88	0.06
73	JS-38	26°21'41.6"	76°51'58.1"	Shale yellowish green	60.08	20.7	8.35	0.11	2.14	1.31	0.08	5.11	0.83	0.06
74	JS-39A	26°21'46.8"	76°52'1.4"	Shale yellowish green	57.34	23.49	7.72	0.04	2.39	0.63	0.09	5.5	0.96	0.06
75	JS-39B	26°21'46"	76°52'1.7"	Shale yellowish green	57.23	22	8.36	0.08	2.56	1.31	0.08	5.89	0.89	0.05
76	JS-40	26°21'50.6"	76°52'5.2"	Shale yellowish green	60.58	21.61	5.39	0.03	2.24	1.27	0.09	5.28	0.89	0.05
78	JS-42	26°21'53"	76°52'7.6"	Shale yellowish green	57.87	19.62	6.42	0.03	2.19	3.49	0.1	5.04	0.81	0.05
79	JS-43A	26°21'58.1"	76°52'8.7"	Shale yellowish green	57.94	21.43	6.57	0.03	2.54	1.93	0.31	5.25	1.29	0.06
80	JS-43B	26°21'56.4"	76°52'7.9"	Shale yellowish green	70.12	14.68	5.3	0.03	1.4	0.29	0.11	3.39	0.88	0.04
81	JS-43C	26°21'56"	76°52'8.4"	Shale yellowish green	60.88	20.31	7.6	0.06	2.42	0.25	0.12	5	1.14	0.06
82	JS-44A	26°22'1.2"	76°52'13.4"	Shale yellowish green	58.17	22.79	7.03	0.03	2.28	0.21	0.13	5.25	1.3	0.08
83	JS-44B	26°22'0.4"	76°52'16.4"	Shale yellowish green	60.63	21.05	7.04	0.06	2.07	0.17	0.13	5.18	1.29	0.08
84	JS-44C	26°22'0.4"	76°52'19.3"	Shale yellowish green	60.42	20.37	7.14	0.05	2.17	0.25	0.12	5.15	1.2	0.06
86	JS-46	26°22'4.6"	76°52'24.7"	Shale yellowish green	57.51	22.3	7.47	0.04	2.21	0.26	0.11	4.79	1.21	0.1
88	JS-48	26°22'12.8"	76°52'26.4"	Shale yellowish green	58.21	21.03	5.99	0.06	2.15	2.41	0.14	4.74	0.93	0.07
89	JS-49	26°22'18.9"	76°52'41.1"	Shale yellowish green	60.43	18.55	3.92	0.02	1.67	4.02	0.11	3.73	0.8	0.1
90	JS-50	26°22'28.1"	76°52'49.9"	Shale brown	65.22	16.23	7.28	0.31	1.6	1.28	0.16	3.08	1.02	0.08
91	JS-51A	26°22'37"	76°52'56.9"	Shale yellowish green	57.39	20.27	7.07	0.04	2.3	4.4	0.11	4.11	1.11	0.06
92	JS-51B	26°22'33.7"	76°52'58.2"	Shale yellowish green	55.97	21.53	5.48	0.03	2.24	2.95	0.11	5.47	1.3	0.06
93	JS-51C	26°22'35.7"	76°53'3"	Shale yellowish green	56.24	19.62	6.55	0.02	2.39	4.36	0.08	4.94	0.85	0.05
94	JS-53	26°22'41.9"	76°52'59.3"	Shale yellowish green	58.98	21.44	6.92	0.03	2.33	1.43	0.1	5.11	1.32	0.06
95	JS-54A	26°22'42.1"	76°53'4.4"	Shale yellowish green	60.4	19.99	7.45	0.06	2.12	1.69	0.1	4.76	1.11	0.06
96	JS-54B	26°22'39.7"	76°53'5"	Shale yellowish green	54.76	21.27	8.15	0.07	2.35	3.32	0.1	5.45	0.88	0.09
98	JS-56	26°17'32.5"	76°48'1.1"	Shale yellow	63.24	16.78	7.23	0.16	1.76	2.04	0.31	4.01	0.86	0.09
99	JS-57	26°17'29.1"	76°47'56.7"	Shale yellowish green	60.12	20.68	7.25	0.07	2.01	0.87	0.15	5.17	0.86	0.07
100	JS-58	26°17'26.6"	76°47'51.3"	Shale yellowish green	54.89	22.75	6.81	0.02	2.28	2.49	0.09	5.99	0.94	0.06
101	JS-59	26°17'26"	76°47'47.8"	Shale yellowish green	58.22	22.59	7.19	0.02	2.21	0.44	0.09	5.95	0.91	0.11
103	JS-62	26°17'5.1"	76°47'38.6"	Varigated shale	58.21	18.23	8.44	0.09	1.63	3.03	0.24	3.03	0.74	0.08
104	JS-63	26°17'4"	76°47'33.7"	Varigated shale	54.85	17.78	5.67	0.06	1.74	8.61	0.25	3.89	0.72	0.08
105	JS-64	26°17'3.7"	76°47'26"	Khaki shale	56.1	22.5	6.44	0.02	2.27	2.35	0.09	4.62	1.32	0.05
106	JS-65	26°16'50.6"	76°46'56.4"	Shale yellowish green, glauconitic siltstone	64.72	14.95	8.04	0.04	1.75	1.26	0.07	4.2	0.82	0.06
107	JS-66	26°16'52.1"	76°46'43"	Khaki shale	61.3	19.83	5.99	0.05	1.95	1.67	0.22	4.75	0.79	0.08
108	JS-67	26°17'1.9"	76°46'25.8"	Khaki shale	57.79	22.09	9.37	0.13	2.1	0.32	0.09	5.33	0.96	0.11
109	JS-68	26°19'4.9"	76°47'36.3"	Shale yellow	64.79	20.07	5.49	0.02	1.71	0.57	0.1	4.12	1.24	0.09
110	JS-69	26°19'9.7"	76°47'37.9"	Shale yellowish green	57.81	21.6	6.85	0.01	2.23	1.4	0.11	4.91	1.27	0.05

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111	JS-70A	26°20'52.2"	76°48'24.8"	Shale yellowish green	57.34	23.95	6.01	0.01	1.95	0.29	0.08	5.5	1.5	0.07
112	JS-71A	26°20'54.2"	76°48'34.6"	Shale yellowish green	59.78	21.33	5.94	0.01	1.79	2.04	0.16	4.39	0.9	0.05
113	JS-73	26°21'5.5"	76°48'26.7"	Shale yellowish green	55.93	20.55	5.65	0.02	2.12	4.04	0.09	4.89	1.25	0.06
114	JS-74	26°21'44.7"	76°48'54.4"	Shale yellowish green	58.77	22.59	6.76	0.02	2.19	0.59	0.1	5	1.24	0.06
117	JS-80	26°26'0.2"	76°54'9"	Shale plae green	58.14	22.76	5.42	0.05	2.45	0.44	0.11	6.64	1.12	0.08
118	JS-81	26°26'7.2"	76°54'13.5"	Shale maroon	69.35	17.72	3.35	0.01	1.8	0.25	0.1	4.88	0.98	0.05
119	JS-105/A	26°17'2.6"	76°47'16.3"	Shale yellow to light green	62.63	18.65	5.63	0.02	1.82	2.38	0.07	3.75	1.19	0.04
120	JS-105/B	26°17'2.6"	76°47'16.3"	Shale yellow to light green	60.75	18.3	5.74	0.04	1.75	3.76	0.06	3.59	1.14	0.04
121	JS-106/A	26°17'2.5"	76°47'16.8"	Shale yellow to light green	63.56	19.61	6.41	0.04	1.77	0.39	0.07	3.87	1.3	0.05
122	JS-106/B	26°17'2.5"	76°47'16.8"	Shale yellow to light green	61.37	19.76	5.41	0.03	1.8	2.22	0.07	3.92	1.23	0.05
123	JS-107/A	26°17'2.6"	76°47'17.2"	Shale yellow to light green	62.1	19.87	7.8	0.05	1.89	0.58	0.07	4.04	1.19	0.13
124	JS-107/B	26°17'2.6"	76°47'17.2"	Shale yellow to light green	57.93	19.25	8.19	0.05	1.85	2.61	0.07	3.65	1.12	0.12
125	JS-108	26°17'2.3"	76°47'17.6"	Shale yellow to light green	59.51	18.66	6.76	0.05	1.99	2.76	0.11	3.75	1.11	0.06
126	JS-109	26°17'2.5"	76°47'18.6"	Shale yellow to light green	56.19	18.53	8.75	0.05	2	3.91	0.1	4.23	1.08	0.16
127	JS-110	26°'''	76°'''	Shale yellow to light green	56.54	18.99	7.29	0.05	2.09	3.42	0.09	4.23	1.17	0.05
128	JS-111/A	26°17'3.1"	76°47'19.4"	Shale yellow to light green	61.17	19.15	7.91	0.03	2.08	1.02	0.08	3.98	1.2	0.05
129	JS-111/B	26°17'3.1"	76°47'19.4"	Shale yellow to light green	59.38	19.69	6.13	0.02	2.03	2.71	0.09	4.13	1.21	0.04
130	JS-112/A	26°17'3.2"	76°47'19.9"	Shale yellow to light green	55.61	18.96	7.43	0.05	2.03	4.76	0.08	3.86	1.12	0.04
131	JS-112/B	26°17'3.2"	76°47'19.9"	Shale yellow to light green	57.5	19.18	5.84	0.03	1.94	4.37	0.08	4.14	1.21	0.05
132	JS-113/A	26°17'3.2"	76°47'20.1"	Shale yellow to light green	57.3	19.41	6.88	0.03	2.15	3.78	0.08	4.09	1.19	0.05
133	JS-113/B	26°17'3.2"	76°47'20.1"	Shale yellow to light green	60.95	18.99	8.09	0.06	2.03	1.64	0.07	4.1	1.15	0.04

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134	JS-114/A	26°17'3.2"	76°47'20.5"	Shale yellow to light green	57.5	19.49	6.3	0.04	2.18	3.59	0.09	4.38	1.21	0.05
135	JS-114/B	26°17'3.2"	76°47'20.5"	Shale yellow to light green	62.04	19.95	6.75	0.03	2.17	0.43	0.08	4.59	1.24	0.05
136	JS-115/A	26°17'3.3"	76°47'20.7"	Shale yellow to light green	59.06	19.72	7.6	0.05	2.27	2.05	0.09	4.34	1.18	0.05
137	JS-115/B	26°17'3.3"	76°47'20.7"	Shale yellow to light green	60.29	20.09	6.83	0.04	2.26	1.37	0.09	4.55	1.28	0.04
138	JS-116/A	26°17'3.3"	76°47'21.2"	Shale yellow to light green	58.96	19.98	7.5	0.04	2.16	2.04	0.08	4.29	1.21	0.07
139	JS-116/B	26°17'3.3"	76°47'21.2"	Shale yellow to light green	56.03	19.85	7.89	0.05	2.17	3.15	0.08	4.46	1.15	0.08
140	JS-117/A	26°17'3.4"	76°47'21.6"	Shale yellow to light green	56.28	19.39	8.02	0.04	2.14	3.81	0.07	3.83	1.1	0.04
141	JS-117/B	26°17'3.4"	76°47'21.6"	Shale yellow to light green	58.62	19.48	7.39	0.05	2.13	2.6	0.08	3.91	1.14	0.05
142	JS-118/A	26°17'3.5"	76°47'21.9"	Shale yellow to light green	59.15	20.19	7.66	0.05	2.22	1.81	0.08	4.37	1.14	0.17
143	JS-118/B	26°17'3.5"	76°47'21.9"	Shale yellow to light green	55.65	20.42	7.91	0.04	2.23	3.73	0.07	4.02	1.16	0.06
144	JS-119/A	26°17'3.5"	76°47'22.2"	Shale yellow to light green	57.65	19.78	7.55	0.04	2.19	2.98	0.08	4.01	1.16	0.05
145	JS-119/B	26°17'3.5"	76°47'22.2"	Shale yellow to light green	58.72	19.74	7.53	0.04	2.21	2.74	0.08	3.85	1.13	0.05
146	JS-120/A	26°17'3.5"	76°47'22.7"	Shale yellow to light green	60.06	21.04	6.18	0.02	2.1	1.72	0.09	4.46	1.22	0.06
147	JS-120/B	26°17'3.5"	76°47'22.7"	Shale yellow to light green	57.34	20.53	6.73	0.02	2.15	3.05	0.08	4.15	1.2	0.05
148	JS-121/A	26°17'3.5"	76°47'23.1"	Shale yellow to light green	60.09	19.03	8.3	0.05	2.21	1.64	0.09	4.36	1.13	0.07
149	JS-121/B	26°17'3.5"	76°47'23.1"	Shale yellow to light green	59.36	18.14	7.47	0.04	2.29	2.47	0.08	4.22	1.18	0.05
150	JS-122/A	26°17'3.5"	76°47'23.5"	Shale yellow to light green	55.02	21.08	7.7	0.02	2.3	3.78	0.08	3.97	1.16	0.08
151	JS-122/B	26°17'3.5"	76°47'23.5"	Shale yellow to light green	58.35	19.94	7.83	0.04	2.21	2.44	0.08	4.07	1.13	0.05

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152	JS-123/A	26°17'3.6"	76°47'24"	Shale yellow to light green	58.28	19.33	7.23	0.03	2.29	3.52	0.08	3.67	1.13	0.04
153	JS-123/B	26°17'3.6"	76°47'24"	Shale yellow to light green	54.8	18.11	7.12	0.04	2.18	6.68	0.07	3.34	1.02	0.04
154	JS-124/A	26°17'3.6"	76°47'24.3"	Shale yellow to light green	54.17	18.63	7.69	0.06	2.16	6.05	0.08	3.41	1.08	0.05
155	JS-124/B	26°17'3.6"	76°47'24.3"	Shale yellow to light green	53.07	18.44	7.74	0.07	2.15	7.03	0.07	3.12	1.01	0.04
156	JS-125/A	26°17'3.6"	76°47'25"	Shale yellow to light green	48.06	18.21	6.01	0.04	2.03	11.6	0.06	3.42	0.92	0.03
157	JS-125/B	26°17'3.6"	76°47'25"	Shale yellow to light green	51.58	19.73	6.63	0.03	2.2	7.35	0.08	3.78	1.05	0.04
158	JS-126/A	26°17'3.6"	76°47'25.5"	Shale yellow to light green	62.34	18.83	8.26	0.07	2.03	0.92	0.06	2.59	1.01	0.04
159	JS-126/B	26°17'3.6"	76°47'25.5"	Shale yellow to light green	62.96	19.26	7.44	0.03	2.24	0.73	0.07	2.9	1.15	0.04
160	JS-127/A	26°17'3.5"	76°47'26"	Shale yellow to light green	52.97	17.96	7.51	0.07	2.09	7.16	0.07	3.2	1.04	0.06
161	JS-127/B	26°17'3.5"	76°47'26"	Shale yellow to light green	50.91	17.16	7.03	0.07	1.88	9.47	0.06	3.47	0.99	0.04
162	JS-128/A	26°17'3.5"	76°47'27.7"	Shale yellow to light green	53.09	18.83	6.78	0.02	1.94	7.44	0.07	3.1	1.07	0.12
163	JS-128/B	26°17'3.5"	76°47'27.7"	Shale yellow to light green	49.94	17.51	5	0.02	1.81	12.71	0.07	3.3	0.96	0.1
164	JS-129	26°17'3.9"	76°47'31.1"	Shale yellow to light green	44.7	14.26	5.44	0.05	1.34	20.01	0.06	2.41	0.7	0.03
165	JS-130	26°17'3.5"	76°47'31.4"	Shale yellow to light green	46.63	16.43	9.57	0.12	1.69	14.24	0.05	2.81	0.8	0.04
166	JS-131	26°17'3.6"	76°47'31.9"	Shale yellow to light green	66.75	16.78	7	0.03	1.92	0.55	0.05	4.03	0.96	0.04
167	JS-132	26°17'3.7"	76°47'32.8"	Shale yellow to light green	59.97	22.6	6.55	0.03	2.11	0.62	0.08	5.16	0.92	0.05
168	JS-133	26°17'4.2"	76°47'33.5"	Shale yellow to light green	52.64	22.33	6.65	0.04	2.12	4.72	0.07	4.84	0.92	0.05
169	JS-134	26°17'4.2"	76°47'33.9"	Shale yellow to light green	58.88	22.09	8.28	0.08	2.07	0.63	0.07	4.88	0.92	0.05

S.No	Sample II	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%	MgO (%	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
170	JS-135	26°17'4.2"	76°47'34.5"	Shale yellow to light green	59.41	22.07	7.04	0.04	1.94	0.57	0.07	4.19	0.93	0.04
171	JS-136	26°17'4.9"	76°47'38.5"	Shale yellow to light green	58.16	21.28	11.31	0.11	1.87	0.55	0.06	3.56	0.85	0.04
172	JS-137/A	26°20'54.7"	76°48'35"	Shale yellowish green	64.23	20.12	4.96	0.02	1.87	0.48	0.1	3.66	0.91	0.04
173	JS-137/B	26°20'54.7"	76°48'35"	Shale yellowish green	62.33	19.55	7.67	0.03	1.7	0.75	0.13	3.79	0.86	0.05
174	JS-137/C	26°20'54.7"	76°48'35"	Shale yellowish green	62.69	20.03	5.45	0.02	1.71	1.78	0.14	3.75	0.88	0.04
175	JS-137/D	26°20'54.7"	76°48'35"	Shale yellowish green	64.9	19.99	5.33	0.01	1.58	0.49	0.14	3.83	0.91	0.04
176	JS-137/E	26°20'54.7"	76°48'35"	Shale yellowish green	64.84	19.48	7.12	0.03	1.59	0.38	0.15	3.95	0.84	0.06
177	JS-137/F	26°20'54.7"	76°48'35"	Shale yellowish green	63.49	19.95	6.25	0.02	1.67	0.41	0.16	4.07	0.9	0.04
178	JS-137/G	26°20'54.7"	76°48'35"	Shale yellowish green	63.3	20.07	5.91	0.02	1.65	1.17	0.19	3.82	0.9	0.04
179	JS-137/H	26°20'54.7"	76°48'35"	Shale yellowish green	64.97	20	5.51	0.01	1.6	0.35	0.15	4.06	0.9	0.04
180	JS-137/I	26°20'54.7"	76°48'35"	Shale yellowish green	64.3	20.52	5.59	0.01	1.66	0.29	0.14	4.36	0.92	0.04
181	JS-137/J	26°20'54.7"	76°48'35"	Shale yellowish green	64.08	20.39	5.86	0.02	1.67	0.29	0.14	4.35	0.9	0.04
182	JS-137/K	26°20'54.7"	76°48'35"	Shale yellowish green	64.73	19.83	5.52	0.09	1.8	0.29	0.13	4.61	0.91	0.04
183	JS-138	26°22'42.4"	76°53'4.8"	Shale yellowish green	60.34	19.04	7.3	0.06	2.1	1.73	0.11	4.33	1.11	0.04
184	JS-139	26°22'42.3"	76°53'4.8"	Shale yellowish green	60.07	18.19	7.28	0.03	2.07	2.47	0.1	4.37	1.11	0.04
185	JS-140	26°22'42.3"	76°53'5"	Shale yellowish green	61.26	18.38	7.32	0.03	1.92	2.23	0.08	4.09	1.07	0.04
186	JS-141	26°22'42.3"	76°53'5.2"	Shale yellowish green	60.1	19.04	6.79	0.05	2.15	2.05	0.11	4.31	1.13	0.04
187	JS-142	26°22'40.9"	76°53'4.3"	Shale yellowish green	61.68	19.01	4.77	0.03	1.94	2.57	0.08	4.62	0.89	0.04
188	JS-143	26°22'40.7"	76°53'4.4"	Shale yellowish green	62.48	20.31	6.72	0.02	2.15	0.4	0.08	4.84	0.83	0.04
189	JS-144	26°22'40.5"	76°53'4.5"	Shale yellowish green	64.31	20.43	5.3	0.05	1.92	0.37	0.08	4.87	0.81	0.03
190	JS-145	26°22'40.3"	76°53'4.6"	Shale yellowish green	62.45	20.35	5.92	0.04	1.96	0.55	0.08	4.83	0.85	0.04
191	JS-146	26°22'40.2"	76°53'4.7"	Shale yellowish green	60.55	19.27	6.89	0.11	1.76	2.45	0.07	4.3	0.81	0.04
192	JS-147	26°22'39"	76°53'4.9"	Shale yellowish green	60.19	21.19	5.9	0.07	2.18	1.09	0.09	5.15	0.86	0.04
193	JS-148	26°22'39.8"	76°53'5"	Shale yellowish green	56.07	20.32	6.5	0.06	2.21	3.83	0.1	4.75	0.86	0.05

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
1	S-26	26°21'15.1"	76°48'49.9"	Olive shale (Quarry)	61.48	19.94	3.33	0.01	1.51	0.19	0.14	4.63	1.04	0.08
2	S-27	26°21'47.6"	76°49'8.5"	Sandstone	68.63	18.27	1.77	0.005	1.03	0.12	0.005	3.27	0.99	0.06
3	S-32B	26°23'29"	76°52'17.9"	Sandstone	81.39	7.84	2.2	0.01	0.59	0.08	0.005	2.39	0.34	0.04
4	S-34	26°24'28.2"	76°53'28.7"	Light green shale	49.7	16.98	2.41	0.01	1	11.53	0.005	2.65	0.87	0.04
5	M-23	26°19'55.9"	76°48'52.4"	Gluconitic sandstone boulder	85.96	4.92	3.37	0.17	0.87	0.02	1.68	0.03	0.08	0.03
6	M-36	26°21'15.2"	76°48'49.9"	Sandstone (Glaucontic)	90.86	3.96	1.02	0.005	0.43	0.06	0.005	0.89	0.08	0.16
7	M-44	26°21'37.8"	76°49'0"	Light green shale	70.29	18.89	1.73	0.01	1.38	0.86	0.02	3.82	1.02	0.08
8	M-48	26°17'40.6"	76°46'53"	Light green shale	73.59	16.98	1.47	0	1.28	0.7	0.005	3.39	1.06	0.11
9	M-119	26°20'54.3"	76°50'32.5"	Glaucontic sandstone	88.9	6.08	1.31	0.01	0.54	0.12	0.005	1.07	0.19	0.13
10	M-125	26°20'29.1"	76°50'17.4"	Galucontic sandstone boulder	88.88	3.73	1.22	0.005	0.96	0.06	0.005	2.03	0.16	0.04
11	M-132	26°22'22.6"	76°50'3.3"	Glauconitic sandstone (Dug well)	93.09	1.17	1.25	0.01	0.21	0.04	0.005	0.75	0.06	0.06
12	M-139	26°21'11.9"	76°50'40.8"	Sandstone	91.34	3.32	1.36	0.01	0.87	0.1	0.01	1.74	0.14	0.03
13	M-144	26°21'59.3"	76°49'43.5"	Galucontic sandstone	90.96	3.11	1.06	0.005	0.54	0.07	0.005	1.05	0.1	0.06
14	M-151	26°23'16.5"	76°50'45.2"	Glauconitic sandstone (Dug well)	91.51	2.56	1.95	0.01	0.9	0.06	0.01	1.51	0.07	0.04
15	M-155	26°21'42.1"	76°51'3.4"	Glauconitic sandstone	58.43	18.49	5.37	0.03	2.08	4.38	0.05	5.93	0.84	0.08
16	FT-2	26°19'54"	76°48'49"	Glauconitic sandstone	95.45	1.24	0.54	0.01	0.19	0.19	0.005	0.25	0.84	0.08
17	M-166C	26°22'46.4"	76°52'29.9"	Glauconitic sandstone	88.67	5.19	2.37	0.01	0.92	0.16	0.01	0.97	0.84	0.07
18	M-171	26°22'28.6"	76°52'25.9"	Sandstone	96.17	1.88	0.38	0.74	0.01	0.01	0.1	0.01	0.84	0.02
19	M -494	26°24'18.9"	76°51'14.2"	Shaley sandstone	69.07	17.79	3.48	0.38	1.59	0.09	2.88	0.01	0.84	0.06
20	M -495	26°24'20.6"	76°51'13.5"	Light green shale	64.1	18.85	4.8	0.18	1.74	0.12	4.94	0.02	0.84	0.07
21	M -528	26°24'54.2"	76°51'45"	Ferrugenious sandstone	58.52	16.15	2.35	9.84	1.54	0.07	2.25	0.01	0.84	0.03
22	M-621	26°23'46.6"	76°52'35"	Shale	76.8	11.4	2.85	0.22	1.17	0.08	3.4	0.02	0.84	0.04
23	M -622	26°23'46"	76°52'37.3"	Shale	70.6	14.32	4.41	0.3	1.51	0.09	3.85	0.04	0.84	0.08
	JS-76	26°23'46.3"	76°52'34.1"	Shale maroon red	65.34	17.13	4.88	0.04	2.15	0.69	0.11	5.32	0.88	0.06
25	JS-77	26°23'43.5"	76°52'37.9"	Shale pale green	66.48	16.75	4.72	0.06	2.25	0.48	0.11	5.3	0.83	0.06
26	JS-78	26°23'37.9"	76°52'30.5"	Shale maroon to pale green	67.43	17.19	4.02	0.03	2.23	0.65	0.11	5.04	0.85	0.05
	JS-82	26°23'35.4"		Shale olive green	64.75	18.55	4.93	0.03	2.45	0.42	0.12	5.16	0.84	0.05
28	JS-83	26°23'35.8"	76°52'27.5"	Shale olive green	63.23	19.11	4.95	0.05	2.51	0.6	0.11	5.63	0.94	0.06
29	JS-84A	26°23'38"	76°52'30.5"	Shale maroon to olive green	65.99	18.13	4.15	0.02	2.35	0.36	0.11	5.23	0.87	0.05
30	JS-84B	26°23'38"		Shale maroon to olive green	68.23	16.53	3.84	0.04	2.17	0.36	0.11	4.98	0.81	0.05
31	JS-85A	26°23'38"		Shale maroon to olive green	68.69	16.12	3.93	0.05	2.1	0.4	0.1	5.04	0.8	0.04
32	JS-85B	26°23'38"	76°52'31.3"	Shale maroon to olive green	65.83	17.4	4.54	0.05	2.24	0.4	0.12	5.09	0.88	0.05
33	JS-86A	26°23'39"	76°52'32.1"	Shale breowin to greenish	62.05	19.84	5.33	0.03	2.57	0.35	0.11	5.52	0.93	0.05
34	JS-86B	26°23'39"		Shale breowin to greenish	63.49	19.34	4.7	0.03	2.63	0.33	0.12	5.6	0.95	0.05
35	JS-87	26°23'40.2"	76°52'32.3"	Shale olive green	66.74	16.12	5.26	0.1	2.44	0.45	0.09	5.01	0.82	0.05

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	MnO (%)	MgO (%)	CaO (%)	Na ₂ O (%)	K ₂ O (%)	TiO ₂ (%)	P ₂ O ₅ (%)
36	JS-88	26°23'41.4"	76°52'35.2"	Shale brown	64.9	17.2	6.42	0.13	2.44	0.54	0.09	4.82	0.84	0.05
37	JS-89	26°23'42.3"	76°52'37.3"	Siltstone	78.65	11.48	3.05	0.02	1.18	0.35	0.07	3.25	0.54	0.05
38	JS-90A	26°23'43.2"	76°52'35.1"	Shale brown	63.94	17.88	6.42	0.08	2.4	0.46	0.1	4.93	0.85	0.05
39	JS-90B	26°23'43.2"	76°52'35.1"	Shale brown	66.61	16.14	5.95	0.1	2.22	0.39	0.1	4.88	0.79	0.05
40	JS-91A	26°23'46.1"	76°52'34"	Shale brownish green	65.18	16.78	5.88	0.09	2.24	0.55	0.1	4.74	0.84	0.05
41	JS-91B	26°23'46.1"	76°52'34"	Shale brownish green	67.86	17.73	4.31	0.01	1.88	0.25	0.1	4.3	0.7	0.05
42	JS-92A	26°23'45.8"	76°52'37.4"	Shale brownish green	64.88	16.99	6.75	0.07	2.18	0.58	0.1	4.43	0.85	0.04
43	JS-92B	26°23'45.8"	76°52'37.4"	Shale brownish green	64.75	19.43	5.3	0.03	2.1	0.35	0.11	4.36	0.73	0.06
44	JS-93A	26°23'24.9"	76°52'14.5"	Shale brown	70.58	14.73	3.78	0.01	1.81	0.31	0.08	4.34	0.68	0.05
45	JS-93B	26°23'24.9"	76°52'14.5"	Shale brown	67.81	17	3.55	0.02	2	0.39	0.09	4.84	0.82	0.05
46	JS-94	26°23'25.8"	76°52'15.6"	Shale gray	52.02	12.41	5.51	0.11	1.79	12.74	0.07	4.02	0.66	0.04
47	JS-95A	26°23'26.9"	76°52'16.2"	Shale yellowish brown	64.84	17.01	6.28	0.08	2.28	0.34	0.09	4.78	0.8	0.05
48	JS-95B	26°23'26.9"	76°52'16.2"	Shale yellowish brown	66.32	16.38	5.77	0.09	2.16	0.43	0.11	4.46	0.77	0.04
49	JS-96A	26°23'29"	76°52'16"	Shale yellow	62.92	17.46	6.49	0.02	2.97	0.63	0.1	3.91	1.01	0.05
50	JS-96B	26°23'29"	76°52'16"	Shale yellow	61.06	17.82	6.24	0.05	3.3	1.65	0.1	4.89	0.95	0.05
51	JS-97A	26°23'28.7"	76°52'18.1"	Shale brown	68.38	15.37	5 (0.11	2.14	0.49	0.09	4.63	0.76	0.05
52	JS-97B	26°23'28.7"	76°52'18.1"	Shale brown	68.03	14.77	4.39	0.06	2.01	1.93	0.08	4.62	0.72	0.04
53	JS-98	26°23'27.8"	76°52'17.5"	Shale/siltstone	73.01	14.25	4.22	0.04	1.72	0.19	0.08	4.4	0.63	0.06
54	JS-99	26°23'27.2"	76°52'18.7"	Shale/siltstone	78.15	12.36	2.16	0.01	1.21	0.15	0.07	3.7	0.57	0.04
55	JS-100	26°23'28.1"	76°52'20.1"	Shale brown	70.82	14	4.19	0.06	1.83	0.38	0.07	4.06	0.64	0.05
56	JS-101A	26°23'29.8"	76°52'21.4"	Shale yellowish brown	66.54	15.65	6.43	0.1	2.22	0.54	0.09	4.64	0.81	0.05
57	JS-101B	26°23'29.8"	76°52'21.4"	Shale yellowish brown	60.01	16.16	5.95	0.12	2.41	4.33	0.09	4.89	0.82	0.05
58	JS-101C	26°23'29.8"	76°52'21.4"	Shale yellowish brown	65.02	15.15	5.59	0.14	2.26	2.51	0.09	4.55	0.74	0.05
59	JS-101D	26°23'29.8"	76°52'21.4"	Shale yellowish brown	67.41	13.42	5.29	0.12	2.04	2.6	0.07	4.35	0.7	0.06
60	JS-102A	26°23'29.9"	76°52'22.1"	Shale brown	62.47	18.03	7.07	0.08	2.46	1.06	0.1	4.69	0.87	0.06
61	JS-102B	26°23'29.9"	76°52'22.1"	Shale gray	58.33	16.04	7.02	0.1	2.34	4.54	0.09	4.77	0.84	0.05
62	JS-103A	26°23'30.4"	76°52'23"	Shale grayiesh brown	65.3	17.23	6.26	0.09	2.42	0.42	0.09	4.92	0.87	0.05
63	JS-103B	26°23'30.4"	76°52'23"	Shale grayiesh brown	60.01	15.03	6	0.12	2.32	4.82	0.08	4.83	0.81	0.07
64	JS-104	26°23'30.9"	76°52'23.7"	Shale gray	66.61	16.47	5.48	0.11	2.47	0.4	0.09	4.82	0.82	0.05
65	S-32A	26°23'29"	76°52'17.9"	Light green shale	59.47	13.84	8.03	0.1	1.48	3.07	0.005	3.91	0.72	0.05

S.No	Sample ID	Latitude	Longitude	Lithology	SiO ₂	Al_2O_3	Fe ₂ O ₃	MnO	MgO	CaO	Na ₂ O	K ₂ O	TiO ₂	P_2O_5
					(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	L-87	26°14'54.4"	76°57'31"	Olive shale	64.8	18.97	4.52	0.02	1.99	0.51	0.22	5.62	1.07	0.34
2	M -577	26°25'58.7"	76°57'11.2"	Light green Sandstone	67.99	15.14	1.61	0.34	3.33	0.47	4.89	0.23	0.84	0.07
				Glauconitic micaceous	3 4 4	70								
3	M-642	26°24'12.9"	76°57'9"	sandstone	62.86	17.58	4.18	0.50	4.25	0.38	4.65	0.04	0.84	0.11
4	M -466	26°23'56.7"	76°55'13.1"	Shaley sandstone	61.74	19.66	5.71	0.26	2.24	0.11	4.76	0.02	0.84	0.06



Geochemical analytical results of core samples, Borehole RKS-1, Sapotra-Karauli sub-basin, Karauli district, Rajasthan

Sl. No.	Sample ID	Sa	ımple leng	th (m)	Lithology	SiO ₂	Al_2O_3	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
		From	То	length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	KS-1/1	6.00	6.75	0.75	Fine grained, cream to reddish siltstone, weatherd	59.91	21.97	6.43	0.54	2.07	0.08	5.74	0.02	0.95	0.04
2	KS-1/2	6.75	7.50	0.75	Fine grained, cream to reddish siltstone, weatherd	63.11	21.25	4.66	0.35	1.89	0.07	5.49	0.02	0.92	0.04
3	KS-1/3	7.50	8.25	0.75	Gray to light green shale with thin band of light maroon shale	59.31	22.07	7.38	0.44	1.99	0.07	5.76	0.03	0.89	0.05
4	KS-1/4	8.25	9.00	0.75	Gray to light green shale with thin band of light maroon shale	57.58	22.37	7.51	0.61	2.14	0.08	6.06	0.04	0.89	0.09
5	KS-1/5	9.00	9.75	0.75	yelloish to light green shale with thin band of maroon shale.	61.41	21.43	5.56	0.46	1.94	0.07	5.60	0.03	0.89	0.05
6	KS-1/6	9.75	10.50	0.75	yelloish to light green shale with thin band of maroon shale.	60.71	22.06	5.59	0.41	1.98	0.07	5.79	0.03	0.92	0.05
7	KS-1/7	10.50	11.25	0.75	Light green to olive shale with thin band of brown shale.	60.87	21.89	5.46	0.37	1.97	0.08	5.77	0.14	0.93	0.05
8	KS-1/8	11.25	12.00	0.75	Light green to olive shale with thin band of brown shale.	60.09	22.17	5.68	0.49	2.08	0.08	5.98	0.05	0.91	0.13
9	KS-1/9	12.00	12.75	0.75	Light green to olive shale with thin band of brown shale and siltstone	60.11	22.09	6.16	0.32	2.16	0.07	6.00	0.03	0.91	0.04
10	KS-1/10	12.75	13.50	0.75	Light green to olive shale with thin band of brown shale and siltstone	58.53	21.95	7.05	0.34	2.20	0.07	6.16	0.08	0.93	0.06
11	KS-1/11	13.50	14.25	0.75	Light green to olive shale with thin band of brown shale and siltstone	59.52	22.77	5.56	0.29	2.02	0.07	6.25	0.03	0.96	0.05
12	KS-1/12	14.25	15.00	0.75	Light green to olive shale with thin band of brown shale and siltstone	59.54	21.80	6.66	0.33	2.15	0.07	6.21	0.02	0.88	0.07

	Sample				****										_
Sl. No.	ID	Sa	mple leng	th (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
					Light green to olive shale with thin										i
13	KS-1/13	15.00	15.75	0.75	band of brown shale	59.08	22.10	7.10	0.30	2.17	0.07	6.25	0.04	0.90	0.05
14	KS-1/14	15.75	16.50	0.75	Light green to olive shale with thin band of brown shale	60.09	21.07	7.09	0.32	2.34	0.07	5.86	0.08	0.89	0.05
15	KS-1/15	16.50	17.25	0.75	Light green to olive shale with thin band of brown shale	60.31	21.71	5.96	0.32	2.23	0.07	5.99	0.04	0.89	0.05
16	KS-1/16	17.25	18.00	0.75	Light green to olive shale with thin band of brown shale	61.45	21.49	5.53	0.33	2.22	0.07	5.80	0.02	0.87	0.05
17	KS-1/17	18.00	18.75	0.75	Light green to olive shale with thin band of light red to brown shale	60.04	20.32	8.95	0.31	2.15	0.07	5.32	0.10	0.85	0.05
18	KS-1/18	18.75	19.50	0.75	Light green to olive shale with thin band of light red to brown shale	61.76	21.72	5.11	0.30	2.21	0.08	5.78	0.02	0.93	0.04
19	KS-1/19	19.50	20.25	0.75	Light green to olive shale with 40% red to brown shale	60.70	20.74	7.60	0.39	2.21	0.08	5.38	0.03	0.88	0.10
20	KS-1/20	20.25	21.00	0.75	Light green to olive shale with 40% red to brown shale	62.06	21.07	6.53	0.31	2.05	0.07	5.16	0.01	0.92	0.05
21	KS-1/21	21.00	21.75	0.75	Maroon to light brown shale with thin bands of light green shale	73.41	14.69	4.56	0.26	1.30	0.05	3.49	0.01	0.66	0.02
22	KS-1/22	21.75	22.50	0.75	Maroon to light brown shale with thin bands of light green shale	58.15	22.96	5.97	0.84	2.29	0.08	6.01	0.03	0.96	0.46
23	KS-1/23	22.50	23.25	0.75	Maroon to light brown shale with thin bands of light green shale	57.03	22.92	7.65	0.33	2.38	0.07	6.30	0.02	0.92	0.06
24	KS-1/24	23.25	24.00	0.75	Maroon to light brown shale with thin bands of light green shale	58.17	22.12	7.02	0.44	2.47	0.08	5.97	0.02	1.00	0.13
25	KS-1/25	24.00	24.75	0.75	Maroon to light brown shale with thin bands of light green shale	58.33	22.01	8.00	0.32	2.34	0.08	5.78	0.03	0.94	0.06
26	KS-1/26	24.75	25.50	0.75	Maroon to light brown shale with thin bands of light green shale	58.94	22.05	6.85	0.34	2.33	0.07	5.96	0.02	0.91	0.06

Sl. No.	Sample ID	Sa	ımple leng	th (m)	Lithology	SiO ₂	Al_2O_3	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
27	KS-1/27	25.50	26.25	0.75	Maroon to light brown shale with thin bands of light green shale	60.04	21.09	6.49	0.31	2.36	0.07	6.00	0.02	0.93	0.05
28	KS-1/28	26.25	27.00	0.75	Maroon to light brown shale with thin bands of light green shale	58.81	21.84	7.27	0.38	2.36	0.07	5.68	0.02	1.02	0.07
29	KS-1/29	27.00	27.75	0.75	Light brown shale with thin band of gray shale	59.15	22.33	6.24	0.85	2.30	0.08	5.75	0.02	0.94	0.38
30	KS-1/30	27.75	28.50	0.75	Light brown shale with thin band of gray shale	58.05	22.05	7.05	0.55	2.46	0.07	6.21	0.04	0.92	0.18
31	KS-1/31	28.50	29.25	0.75	Light green shale with bands of maroon shale	58.95	21.77	7.05	0.30	2.43	0.07	6.00	0.02	0.94	0.05
32	KS-1/32	29.25	30.00	0.75	Light green shale with bands of maroon shale	57.69	21.28	9.38	0.30	2.22	0.07	6.20	0.09	0.82	0.06
33	KS-1/33	30.00	30.75	0.75	Light green shale with bands of maroon shale	58.89	20.96	8.03	0.30	2.36	0.07	5.79	0.05	0.94	0.05
34	KS-1/34	30.75	31.50	0.75	Light green shale with bands of maroon shale	67.96	15.91	8.30	0.33	1.84	0.05	3.30	0.02	0.63	0.03
35	KS-1/35	31.50	32.25	0.75	Light green shale with bands of maroon shale	59.34	22.09	6.04	0.30	2.51	0.08	6.28	0.02	0.97	0.05
36	KS-1/36	32.25	33.00	0.75	Light green shale with bands of maroon shale	59.05	21.85	6.53	0.31	2.50	0.08	6.34	0.02	0.91	0.05
37	KS-1/37	33.00	33.75	0.75	Light green shale with bands of maroon shale	58.52	21.84	7.01	0.34	2.58	0.08	6.28	0.02	0.92	0.06
38	KS-1/38	33.75	34.50	0.75	Light green shale with bands of maroon shale	65.87	17.61	7.94	0.33	1.88	0.06	3.53	0.02	0.69	0.03

Annexure-10

$Geochemical\ analytical\ results\ of\ core\ samples,\ Borehole\ RKS-2, Sapotra-Karauli\ sub-basin\ ,\ Karauli\ district,\ Rajasthan$

Sl. No.	Sample	Samp	le leng	th (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	Total lengt	h	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
	1 KS-2/1	3	3.75	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of siltstone	65.16	19.19	6	0.33	1.81	0.08	4.67	0.02	1.15	0.04
	2 KS-2/2	3.75	4.5	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of siltstone	61.04	21.05	6.56	0.37	2.12	0.1	5.51	0.07	1.27	0.07
	3 KS-2/3	4.5	5.25	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of siltstone	60.07	20.15	8.25	0.6	2.06	0.09	5.33	0.13	1.18	0.26
	4 KS-2/4	5.25	6	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of siltstone	62.18	20.69	6.32	0.35	2.03	0.09	5.09	0.05	1.21	0.04
	5 KS-2/5	6	6.75	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of sandstone	61.41	21.15	6.26	0.34	2.08	0.09	5.2	0.04	1.21	0.04
	6 KS-2/6	6.75	7.5	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of sandstone	61.55	20.16	7.8	0.35	2.06	0.09	5	0.03	1.14	0.05

Sl. No.	Sample	Samp	le leng	th (m)	Lithology	SiO ₂	Al_2O_3	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	Total lengt	ih	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
	7 KS-2/7	7.5	8.25	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of sandstone	61.79	20.49	6.41	0.31	2.05	0.09	5.25	0.05	1.19	0.05
	8 KS-2/8	8.25	9	0.75	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of sandstone	62.08	21	5.91	0.35	1.99	0.11	5.45	0.04	1.33	0.05
	9 KS-2/9	9	10	1	Maroon shale with thin parting siltstone	60.64	20.57	8.1	0.37	1.76	0.09	4.95	0.1	1.24	0.05
1	0 KS-2/10	10	11	1	Light maroon colour shale with thin parting of yellow shale	63.81	19.77	6.26	0.36	1.82	0.09	4.89	0.04	1.26	0.04
1	1 KS-2/11	11	12.5	1.5	Light maroon colour shale with thin parting of yellow-green shale	60.17	20.44	7.91	0.33	2.04	0.09	5.4	0.12	1.2	0.05
1	2 KS-2/12	12.5	13.5	1	Glauconitic Sst	74.72	13.05	4.59	0.25	1.2	0.05	3.58	0.05	0.72	0.04
1	3 KS-2/13	13.5	15	1.5	Medium to coarse grain, light red color sandstone followed by maroon shale	60.3	19.64	9.03	0.39	2.07	0.08	4.88	0.02	0.93	0.04
1	4 KS-2/14	15	16	1	Light maroon colour shale with thin parting of yellow shale	61.74	20.3	6.56	0.63	1.84	0.08	5.35	0.13	0.86	0.28
1	5 KS-2/15	16	17	1	Light maroon colour shale with thin parting of yellow shale	61.53	21.62	5.47	0.28	1.98	0.08	5.64	0.06	0.92	0.05
1	6 KS-2/16	17	18	1	Light maroon colour shale with thin parting of yellow shale	61.09	21.84	5.68	0.27	1.95	0.08	5.78	0.08	0.96	0.05

Sl. No.	Sample	Samp	le leng	th (m)	Lithology	SiO ₂	Al_2O_3	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	Total lengt	ih	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
17	7 KS-2/17	18	19	1	Light maroon colour shale with thin parting of yellowish green shale, thin band of sandstone	62.75	20.58	6.17	0.25	1.74	0.07	5.33	0.06	0.93	0.05
18	8 KS-2/18	19	20	1	Light brown to yellowish shale with thin band of sandstone	61.69	21.76	5.22	0.27	1.89	0.08	5.66	0.06	0.97	0.05
19	9 KS-2/19	20	21	1	Light brown to yellowish shale with thin band of maroon shale	57.55	23.17	6.83	0.29	2.14	0.08	6.36	0.03	0.99	0.05
20	KS-2/20	21	22	1	Light brown to yellowish shale with thin band of maroon shale	21 PM 21 20 3 3 4 1 1	20.11	4.57	0.27	1.61	0.07	5.1	0.02	0.86	0.05
2	1 KS-2/21	22	23	1	Light brown to yellowish shale with thin band of maroon shale	7 - 7 - 7 - 7	21.71	5.98	0.23	1.75	0.08	5.55	0.04	0.96	0.05
22	2 KS-2/22	23	24	1	Light brown to yellowish shale with thin band of maroon shale	60.91	21.29	6.9	0.23	1.85	0.08	5.43	0.14	0.97	0.04
23	3 KS-2/23	24	25	1	Light brown to yellowish shale with thin band of maroon shale	59.1	22.24	6.94	0.25	1.93	0.08	5.94	0.06	0.93	0.06
24	4 KS-2/24	25	26	1	Light brown to yellowish shale with thin band of olive shale	58.97	22.4	6.19	0.27	2.21	0.08	6.17	0.02	0.96	0.05
25	5 KS-2/25	26	27	1	Light brown to yellowish shale with thin band of olive shale	59.77	22.18	5.79	0.24	2.21	0.09	6.03	0.05	0.94	0.05
20	6 KS-2/26	27	28	1	Olive green shale with thin bands of cream shale	59.89	22.4	5.44	0.25	2.27	0.08	6.15	0.08	0.97	0.04

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Sl. No.	Sample	Samp	le leng	th (m)	Lithology	SiO ₂	Al_2O_3	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	To	Total leng	th	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
27	KS-2/27	28	29	1	Olive green to light yellow shale with thin bands of maroon shale	61.94	21.46	5.73	0.25	2.16	0.08	5.48	0.02	0.94	0.05
28	8 KS-2/28	29	30	1	Olive green to light yellow shale with thin bands of maroon shale	63.01	20.39	5.74	0.35	2.15	0.08	5.5	0.02	0.91	0.09
29	KS-2/29	30	31	1	Olive green to light yellow shale with thin bands of maroon shale	64.78	19.16	5.69	0.3	2.04	0.08	5.09	0.03	0.85	0.04
30	KS-2/30	31	32	1	Olive green to light yellow shale with thin bands of maroon shale	63.01	20.99	4.59	0.2	2.07	0.08	5.5	0.02	0.97	0.04
31	KS-2/31	32	33	1	Olive green to light yellow shale with thin bands of maroon shale	63.98	20.42	5.07	0.45	1.96	0.08	5.16	0.04	0.88	0.21
32	2 KS-2/32	33	34	1	Olive green to light yellow shale with thin bands of maroon shale	60.1	20.8	7.01	0.38	2.29	0.08	5.42	0.06	0.92	0.13
33	KS-2/33	34	35	1	Olive green to light yellow shale with thin bands of maroon shale	59.48	21.8	7.07	0.23	2.33	0.09	5.71	0.09	0.92	0.06

Geochemical analytical results of core samples, Borehole RKS-3, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl. No.	Sample ID	Sam	ple len	gth (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	KS-3/1	6.00	7.00	1.00	Light Brownish to maroon shale inntercalated with thin bands of olive shale and siltstone	63.99	20.29	5.94	0.24	1.50	0.10	4.64	0.02	1.37	0.05
2	KS-3/2	7.00	8.00	1.00	Light Brownish shale intercalated with thin band of siltstone	60.98	22.83	5.01	0.27	1.73	0.09	5.42	0.03	1.63	0.06
3	KS-3/3	8.00	9.00	1.00	Light Brownish shale intercalated with thin band of siltstone and olive shale	62.18	22.03	5.49	0.23	1.60	0.08	5.13	0.05	1.52	0.05
4	KS-3/4	9.00	10.00	1.00	Light Brownish shale intercalated with thin band of olive shale	60.81	22.73	5.05	0.28	1.86	0.09	5.64	0.08	1.52	0.05
5	KS-3/5	10.00	11.00	1.00	Brownish to maroon shale with thinly laminated olive shale	61.22	21.73	6.04	0.29	1.89	0.08	5.30	0.03	1.37	0.05
6	KS-3/6	11.00	12.00	1.00	Brownish to maroon shale with thinly laminated olive shale	62.30	20.97	5.85	0.26	1.78	0.08	5.06	0.03	1.38	0.05
7	KS-3/7	12.00	13.00	1.00	Brownish to maroon shale with thinly laminated olive shale	62.06	21.43	5.69	0.26	1.84	0.08	5.21	0.02	1.48	0.05
8	KS-3/8	13.00	14.00	1.00	Brownish to maroon shale with thinly laminated olive shale	64.19	19.37	6.32	0.25	1.85	0.08	4.60	0.02	1.36	0.04

Sl. No.	Sample ID	San	ıple len	gth (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
9	KS-3/9	14.00	15.00	1.00	Brownish to light yellow shale with thinly laminated olive shale	62.91	20.82	5.67	0.23	1.84	0.08	5.19	0.06	1.35	0.04
10	KS-3/10	15.00	16.00	1.00	Brownish to light yellow shale with thinly laminated olive shale	63.97	19.92	6.25	0.25	1.80	0.07	4.78	0.02	1.25	0.04
11	KS-3/11	16.00	17.00	1.00	Brownish to light yellow shale with thinly laminated olive shale	61.83	20.24	7.26	0.28	1.96	0.08	5.03	0.03	1.27	0.05
12	KS-3/12	17.00	18.00	1.00	Brownish to light yellow shale with thinly laminated olive shale	60.30	19.28	9.61	0.29	1.99	0.07	4.84	0.15	1.16	0.05
13	KS-3/13	18.00	19.00	1.00	Olive to brownish shale with thin band of maroon shale	62.76	19.13	7.35	0.27	2.00	0.07	4.73	0.03	1.21	0.04
14	KS-3/14	19.00	20.00	1.00	Olive to brownish shale with thin band of maroon shale	60.79	20.19	7.40	0.31	2.16	0.08	5.10	0.02	1.22	0.04
15	KS-3/15	20.00	21.00	1.00	Olive to brownish shale with thin band of maroon shale	61.81	20.24	6.95	0.27	2.08	0.08	5.23	0.06	1.18	0.05
16	KS-3/16	21.00	22.00	1.00	Olive to brownish shale with thin band of maroon shale	61.38	19.83	7.59	0.29	2.14	0.08	4.98	0.03	1.17	0.04
17	KS-3/17	22.00	23.00	1.00	Olive to brownish shale with thin band of maroon shale	60.25	20.59	7.43	0.31	2.17	0.08	5.30	0.08	1.17	0.05
18	KS-3/18	23.00	24.00	1.00	Olive to brownish shale with thin band of maroon shale	61.58	19.47	8.32	0.28	2.05	0.08	5.03	0.05	1.11	0.05
19	KS-3/19	24.00	25.00	1.00	Olive to brownish shale with thin band of maroon shale	61.24	19.98	7.40	0.27	2.06	0.08	5.23	0.07	1.15	0.05

Geochemical analytical results of core samples, Borehole RKS-3, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl. No.	Sample ID	Sam	ple len	gth (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
		From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length											
20	KS-3/20	25.00	26.00	1 1 00	Olive to brownish shale with thin band of maroon shale	61.42	20.40	6.66	0.28	2.05	0.08	5.36	0.11	1.16	0.05
21	KS-3/21	26.00	27.00	1.00	Olive to brownish sahle,Intercalation of sandstone and thinly laminated glauconitic sandstone	64.60	17.03	8.24	0.27	1.78	0.06	4.78	0.09	1.01	0.06
22	KS-3/22	27.00	28.00	1.00	Brownish to olive sahle	61.04	19.67	8.89	0.26	1.90	0.08	5.04	0.22	0.86	0.05
23	KS-3/23	28.00	29.00	1.00	Brownish to olive sahle	61.08	21.93	5.39	0.24	2.03	0.08	5.68	0.03	0.97	0.04
24	KS-3/24	29.00	30.00	1.00	Brownish to olive sahle	59.55	21.11	8.03	0.44	2.02	0.06	5.95	0.03	0.87	0.10
25	KS-3/25	30.00	30.50	0.50	Brownish to olive sahle	61.85	21.43	5.41	0.33	1.99	0.07	5.53	0.03	0.91	0.04

Sl. No.	Sample ID	Samp	le leng	gth (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
NO.	ID	From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	KS-4/1	5.00	6.00	1.00	Brownish to yellow shale with thinly laminated gray shale	62.12	23.03	4.67	0.31	1.75	0.13	5.01	0.04	0.80	0.05
2	KS-4/2	6.00	7.00	1.00	Brownish to yellow shale with thinly laminated gray shale	61.19	24.19	5.16	0.25	1.63	0.13	5.03	0.02	0.80	0.05
	KS-4/3	7.00			Brownish to yellow shale with thinly laminated gray shale		23.56		0.32	1.79	0.12	4.87	0.04	0.79	0.05
	KS-4/4 KS-4/5	8.00	9.00 10.00		Grey to light brown shale Grey to light brown shale	-1677	23.76 22.97		0.24	1.80 1.63	0.13	5.05 4.88	0.04	0.83 0.79	0.05
	KS-4/6		11.00		Grey to light brown shale		23.03		0.31	1.56	0.12	4.79	0.05	0.79	0.05
7	KS-4/7	11.00	12.00	1.00	Brownish to yellow shale with thinly laminated gray shale	59.07	23.20	7.29	0.35	1.80	0.12	4.84	0.05	0.84	0.05
8	KS-4/8	12.00	13.00	1.00	Grey to light brown shale	58.79	22.98	7.93	0.52	1.60	0.11	4.96	0.02	0.81	0.06
9	KS-4/9	13.00	14.00	1.00	Grey to brownish	59.98	23.98	5.66	0.30	1.56	0.10	5.32	0.03	0.88	0.06
	KS-4/10				Brownish to yellow shale with thinly laminated gary gay shale		23.30		0.36	1.68	0.10	5.03	0.04	0.82	0.06
	KS-4/11				Grey to light brown shale		23.54	115	0.30	1.67	0.10	5.07	0.05	0.84	0.06
	KS-4/12				Olive to light brown shale	59.91	22.79		0.34	1.74	0.10	4.99	0.05	0.87	0.06
	KS-4/13				Light brown to light green shale				0.28	1.56	0.10	5.29	0.04	0.83	0.06
	KS-4/14 KS-4/15				Light brown to light green shale Light brown to light green shale		24.08		0.29	1.58 1.65	0.10	5.29 4.99	0.03	0.84 0.87	0.06
	KS-4/15 KS-4/16				Light brown to light green shale		23.14 21.99		0.34	1.65	0.09	4.99	0.05	0.87	0.06
	KS-4/10				Light brown to light green shale		22.75		0.33	1.59	0.09	4.76	0.05	0.88	0.05
	KS-4/18				Light brown to light green shale		23.25		0.26	1.38	0.10	5.21	0.03	0.86	0.05
	KS-4/19				Light brown to light green shale		23.88		0.29	1.46	0.10	5.08	0.03	0.89	0.08
	KS-4/20				Light brown to light green shale		22.67		0.29	1.52	0.10	4.84	0.05	0.88	0.07

Geochemical analytical results of core samples, Borehole RKS-4, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Annexure-12

Sl.	Sample	Samp	le leng	th (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID														
		From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length											
					Olive-gray shale with thin bands of brownish										
21	KS-4/21	25.00	26.00	1.00	shale	59.90	22.44	7.67	0.30	1.63	0.10	4.77	0.04	0.83	0.05
					Olive-gray shale with thin bands of brownish	Ų,									
22	KS-4/22	26.00	27.00	1.00	shale	60.70	22.87	6.63	0.29	1.52	0.10	5.01	0.04	0.87	0.06
					Olive-gray shale with thin bands of brownish	18:									
23	KS-4/23	27.00	28.00	1.00	shale	61.72	23.46	5.26	0.32	1.45	0.10	5.19	0.03	0.87	0.06
					Olive-gray shale with thin bands of brownish		0	K							
24	KS-4/24	28.00	29.00	1.00	shale	58.95	22.35	9.13	0.40	1.50	0.10	4.88	0.06	0.80	0.06
					Olive-gray shale with thin bands of brownish	Ų.		1							
25	KS-4/25	29.00	30.00	1.00	shale	58.98	23.14	7.99	0.34	1.61	0.11	5.24	0.04	0.83	0.06

Geochemical analytical results of core samples, Borehole RKS-5, Sapotra-Karauli sub-basin , Karauli district, Rajasthan.

Sl. No.	Sample	S	ample	length	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
	ID	From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	KS-5/1	4.00	5.00	1.00	Olive gray to thin bands of brown coloured	64.86	19.74	5.60	0.38	1.75	0.09	4.5	0.02	1.19	0.04
2	KS-5/2	5.00	6.00	1.00	Gray to light green shale with thin band of siltstone at places	62.27	20.17	7.20	0.60	1.82	0.09	4.5	0.02	1.23	0.04
3	KS-5/3	6.00	7.00	1.00	Gray to light green shale with thin band of siltstone at places	62.44	19.11	7.15	1.06	1.66	0.09	4.3	0.04	1.10	0.04
4	KS-5/4	7.00	8.00	1.00	Gray to light green shale with thin band of siltstone at places	62.99	19.38	7.62	0.54	1.83	0.09	4.4	0.05	1.14	0.04
5	KS-5/5	8.00	9.00	1.00	Gray to light green shale with thin band of siltstone at places	62.98	19.16	7.55	0.40	1.81	0.08	4.5	0.03	1.18	0.04
6	KS-5/6	9.00	10.00	1.00	Gray to light green shale with thin band of siltstone at places	64.92	18.48	6.89	0.39	1.74	0.07	4.4	0.02	1.18	0.03
7	KS-5/7	10.00	11.00	1.00	gray to light green shale with thin band of siltstone at places	62.75	18.84	7.83	0.40	1.85	0.08	4.4	0.03	1.12	0.04
8	KS-5/8	11.00	12.00	1.00	gray to light green shale with thin band of siltstone at places	62.90	18.60	8.10	0.40	1.83	0.08	4.3	0.08	1.08	0.05
9	KS-5/9	12.00	13.00	1.00	gray to light green shale with thin band of siltstone at places	63.50	19.43	7.02	0.37	1.82	0.08	4.8	0.05	1.14	0.04
10	KS-5/10	13.00	14.00	1.00	gray to light green shale with thin band of siltstone at places	61.28	19.90	7.84	0.38	1.91	0.08	4.9	0.05	1.10	0.04

Geochemical analytical results of core samples, Borehole RKS-5, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl. No.	Sample	S	ample	length	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
	ID	From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
11	KS-5/11	14.00	15.00	1.00	Gray to light green shale with thin band of siltstone at places	62.56	19.01	7.59	0.34	1.81	0.08	4.8	0.19	1.10	0.05
12	KS-5/12	15.00	16.00	1.00	Gray to light green shale with thin band of siltstone at places	63.18	19.31	6.63	0.39	1.84	0.08	4.9	0.04	1.13	0.04
13	KS-5/13	16.00	17.00	1.00	Gray to light green shale with thin band of glaucomitic sandstone 40 cm	65.94	17.44	6.84	0.37	1.70	0.07	4.5	0.07	1.07	0.05
14	KS-5/14	17.00	18.00	1.00	Gray to light green shale with top 50 cm is glauconitic sandstone	64.38	17.97	7.48	0.36	1.78	0.07	5.0	0.04	0.87	0.05
15	KS-5/15	18.00	19.00	1.00	Gray to light green shale with thin band of siltstone at places	59.05	19.77	10.36	0.34	1.82	0.07	4.9	0.19	0.78	0.04
16	KS-5/16	19.00	20.00	1.00	Gray to light green shale with thin band of siltstone at places	64.39	18.97	6.43	0.32	1.62	0.06	4.9	0.03	0.88	0.04
17	KS-5/17	20.00	21.00	1.00	Gray to light green shale with thin band of siltstone at places	64.19	20.10	5.59	0.33	1.73	0.06	5.1	0.05	0.97	0.04
18	KS-5/18	21.00	22.00	1.00	Gray to light green shale	60.01	21.20	7.74	0.35	1.84	0.06	5.9	0.08	0.90	0.09
	KS-5/19		23.00		Gray to light green shale	61.96	21.01	6.00	0.33	1.77	0.06	5.6	0.03	0.90	0.06
	KS-5/20		24.00		Gray to light green shale	65.27	17.40	8.45	0.32	1.43	0.05	4.2	0.27	0.77	0.04
	KS-5/21		25.00		Gray to light green shale	65.73	19.82	4.55	0.33	1.62	0.06	4.9	0.04	0.91	0.07
	KS-5/22	25.00			Gray to light green shale	64.62	19.05	6.29	0.30	1.60	0.06	4.7	0.04	0.87	0.04
	KS-5/23		27.00		Gray to light green shale	61.86	20.88	6.13	0.31	1.81	0.07	5.4	0.04	0.88	0.05
24	KS-5/24	27.00	28.00	1.00	Gray to light green shale	60.89	21.35	6.60	0.43	1.85	0.06	5.6	0.05	0.89	0.12

Geochemical analytical results of core samples, Borehole RKS-5, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl. No.	Sample	S	ample	length	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
	ID	From		Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
25	KS-5/25	28.00	29.00	1.00	Gray to light green shale	61.90	20.83	6.59	0.31	1.89	0.06	5.4	0.03	0.94	0.05
	KS-5/26		30.00		Gray to light green shale	63.45	19.49	6.65	0.29	1.76	0.06	4.9	0.02	0.88	0.05
27	KS-5/27		31.00		Gray to light green shale	62.97	20.35	6.16	0.28	1.82	0.07	5.1	0.05	0.93	0.04
	KS-5/28		32.00		Gray to light green shale	61.73	20.71	6.90	0.32	1.89	0.07	5.2	0.03	0.94	0.04
29	KS-5/29	32.00	33.00	1.00	Olive green to dark gray shale	60.44	21.21	7.05	0.35	1.94	0.06	5.5	0.02	0.95	0.09
30	KS-5/30	33.00	34.00	1.00	Olive green to dark gray shale	62.74	20.55	6.45	0.31	1.88	0.06	5.1	0.05	0.94	0.04
31	KS-5/31	34.00	35.00	1.00	Olive green to dark gray shale	59.21	21.57	7.57	0.33	2.02	0.06	5.8	0.07	0.91	0.05
32	KS-5/32	35.00	36.00	1.00	Olive green to dark gray shale	62.07	20.34	6.68	0.32	1.97	0.07	5.2	0.03	0.89	0.05
33	KS-5/33	36.00	37.00	1.00	Olive green to dark gray shale	63.02	20.36	6.06	0.32	1.93	0.08	5.1	0.03	0.91	0.04
34	KS-5/34	37.00	38.00	1.00	Olive green to dark gray shale	62.96	19.36	7.43	0.34	1.89	0.07	4.8	0.03	0.88	0.04
35	KS-5/35	38.00	39.00	1.00	Olive green to dark gray shale	63.94	19.83	5.79	0.30	1.83	0.09	4.9	0.08	0.87	0.04
36	KS-5/36	39.00	40.00	1.00	Olive green to dark gray shale	62.08	21.00	6.17	0.38	1.97	0.07	5.4	0.05	0.90	0.08
37	KS-5/37	40.00	41.00	1.00	Olive green to dark gray shale	60.93	20.39	7.31	0.39	1.98	0.08	5.2	0.10	0.87	0.05
38	KS-5/38	41.00	42.00	1.00	Olive green to dark gray shale	59.85	20.80	7.46	0.48	2.06	0.09	5.4	0.11	0.87	0.06
39	KS-5/39	42.00	43.00	1.00	Olive green to dark gray shale	60.36	21.29	6.63	0.36	2.15	0.08	5.6	0.03	0.89	0.07

Geochemical analytical results of core samples, Borehole RKS-5, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl. No.	Sample	S	ample	length	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
	ID	From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length											
40	KS-5/40	43.00	44.00	1.00	Olive green to dark gray shale	60.92	20.48	7.40	0.32	2.11	0.08	5.3	0.09	0.90	0.05
41	KS-5/41	44.00	45.00	1.00	Olive green to dark gray shale	60.57	20.71	7.60	0.34	2.06	0.08	5.3	0.09	0.87	0.07

Geochemical analytical results of core samples, Borehole RKS-6, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl.	Sample	Samp	le leng	th (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
No.	ID	From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length											
1	KS-6/1	3.00	4.00	1.00	Light brown to redish shale	61.30	21.83	7.40	0.33	1.54	0.08	4.52	0.03	0.76	0.05
2	KS-6/2	4.00	5.00	1.00	gray to light brown shale	60.04	23.19	7.34	0.22	1.52	0.09	4.90	0.04	0.83	0.05
3	KS-6/3	5.00	6.00	1.00	gray to light brown shale	61.88	23.19	5.33	0.20	1.55	0.09	4.78	0.03	0.84	0.05
4	KS-6/4	6.00	7.00	1.00	gray to light brown shale	61.58	21.66	7.81	0.25	1.57	0.08	4.44	0.08	0.82	0.06
5	KS-6/5	7.00	8.00	1.00	gray to light brown shale	61.93	22.53	5.77	0.23	1.50	0.09	4.76	0.04	0.81	0.05
6	KS-6/6	8.00	9.00	1.00	Light yellow to gray shale	60.96	22.98	6.65	0.27	1.65	0.09	4.80	0.02	0.84	0.05
					Light yellow to gray shale with				92/						
7	KS-6/7	9.00	10.00	1.00	thin band of sandstone	62.38	21.80	7.19	0.25	1.50	0.07	4.49	0.04	0.78	0.05
					Light yellow to gray shale with	11/14		8	<u> </u>						
8	KS-6/8	10.00	11.00	1.00	thin band of sandstone	60.57	21.77	9.12	0.24	1.38	0.08	4.67	0.05	0.79	0.05
					Light yellow to gray shale with		21/1	~		1					
9	KS-6/9	11.00	12.00	1.00	thin band of sandstone	60.93	23.60	5.97	0.27	1.50	0.09	5.00	0.04	0.87	0.06
					Light yellow to gray shale with	जनव य		10	AI						
10	KS-6/10	12.00	13.00		thin band of sandstone	60.06	23.79	5.97	0.26	1.50	0.08	5.00	0.03	0.89	0.06
11	KS-6/11	13.00	14.00		Light yellow to gray shale	62.55	22.72	5.29	0.25	1.45	0.08	5.23	0.02	0.93	0.06
12	KS-6/12	14.00	15.00	1.00	Light yellow to gray shale	60.75	22.27	7.19	0.28	1.60	0.08	4.78	0.02	0.86	0.05
					Light yellow to gray shale with										
13	KS-6/13	15.00	16.00	1.00	thin band of sandstone	60.50	22.09	7.40	0.31	1.70	0.08	5.05	0.04	0.93	0.07
					Light yellow to gray shale with										
14	KS-6/14	16.00	17.00	1.00	thin lamination of brown shale	59.78	22.53	7.97	0.30	1.73	0.08	4.98	0.05	0.91	0.06
					Light yellow to gray shale with										
15	KS-6/15	17.00	18.00	1.00	thin lamination of brown shale	59.72	23.04	6.85	0.29	1.60	0.08	5.08	0.03	0.91	0.06

Geochemical analytical results of core samples, Borehole RKS-6, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Annexure-14

Sl.	Sample	Samp	ole leng	th (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
No.	ID	From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length											
					Light yellow to gray shale with										
16	KS-6/16	18.00	19.00	1.00	thin lamination of brown shale	60.79	22.43	7.15	0.30	1.60	0.08	4.88	0.03	0.89	0.06
					Light yellow to gray shale with		/ =								
17	KS-6/17	19.00	20.00	1.00	thin lamination of brown shale	61.46	23.24	5.53	0.30	1.51	0.09	5.14	0.02	0.91	0.06
					Light yellow to gray shale with		1		115						
18	KS-6/18	20.00	21.00	1.00	thin lamination of brown shale	59.52	23.05	6.93	0.29	1.55	0.09	5.06	0.03	0.86	0.06
					Light yellow to gray shale with		A	-7.	10	\					
19	KS-6/19	21.00	22.00	1.00	thin lamination of brown shale	60.35	22.51	7.03	0.30	1.65	0.08	4.87	0.03	0.85	0.05
					Light yellow to gray shale with	THE STATE OF))	2							
20	KS-6/20	22.00	23.00	1.00	thin lamination of brown shale	59.08	22.19	8.86	0.33	1.77	0.09	4.88	0.05	0.83	0.08
					Light yellow to gray shale with			8 7							
21	KS-6/21	23.00	24.00	1.00	thin lamination of brown shale	60.60	22.29	6.92	0.28	1.62	0.09	4.79	0.06	0.86	0.05
					Light yellow to gray shale with	ZZ			/						
22	KS-6/22	24.00	25.00	1.00	thin lamination of brown shale	61.35	22.77	6.25	0.26	1.39	0.09	5.00	0.05	0.83	0.05
					Light yellow to gray shale with	8.5	0		4/						
23	KS-6/23	25.00	26.00	1.00	thin lamination of brown shale	62.91	22.88	5.13	0.22	1.27	0.09	5.00	0.03	0.87	0.06
					Light yellow to gray shale with	3000									
24	KS-6/24	26.00	27.00	1.00	thin lamination of brown shale	60.61	21.70	7.73	0.32	1.76	0.08	4.63	0.03	0.94	0.05
					Light yellow to gray shale with										
25	KS-6/25	27.00	28.00	1.00	thin lamination of brown shale	61.12	22.91	6.82	0.27	1.54	0.08	4.78	0.02	0.90	0.05
					Light yellow to gray shale with										
26	KS-6/26	28.00	29.00	1.00	thin lamination of brown shale	60.11	23.14	6.69	0.25	1.56	0.08	5.03	0.06	0.87	0.06
27	KS-6/27	29.00	30.00	1.00	Light brown to red	59.71	23.49	7.02	0.26	1.67	0.08	5.09	0.10	0.89	0.06

Annexure-15 Geochemical analytical results of core samples, Borehole RKS-7, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Α

Sl.	Sample	San	nple le	ngth	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From		Total	SET	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	KS-7/1	1.00		length 1.00	Medium grained, cream to light brown sandstone, glauconite varies from 10 to 15%	92.97	3.22	1.01	0.09	0.40	0.01	1.25	0.01	0.06	0.04
2	KS-7/2	2.00	3.00	1.00	Medium grained, cream to light brown sandatone, glauconite varies from 1 to 2%, lower part yellow shale	92.41	3.42	1.63	0.06	0.37	0.01	0.87	0.09	0.07	0.02
3	KS-7/3	3.00	3.50	0.50	Gray to light green shale	88.38	4.48	3.34	0.10	0.60	0.02	1.32	0.03	0.13	0.06
4	KS-7/4	3.50	4.00	0.50	Gray to light green shale	65.08	19.55	4.37	0.19	2.26	0.09	5.13	0.01	1.12	0.08
5	KS-7/5	4.00	5.00	1.00	Medium grained, Gray to light brown sandstone, with 40 cm band of Gray shale	65.99	17.84	6.16	0.22	1.91	0.10	4.68	0.01	1.05	0.06
6	KS-7/6	5.00	5.50	0.50	Medium to coarse grained, Gray sandstone, top 20 cm having glauconite 30% along lamination planes, thin band of Gray shale	86.95	4.87	3.61	0.14	0.62	0.02	1.51	0.01	0.21	0.08
7	KS-7/7	5.50	6.00	0.50	Medium to coarse grained, Gray sandstone, top 20 cm having glauconite 30% along lamination planes, thin band of Gray shale	65.51	18.48	5.55	0.25	2.01	0.08	4.93	0.02	1.14	0.09
8	KS-7/8	6.00	6.50	0.50	Medium to fine grained, cream sandstone with thin band of gray shale, having band glauconitic sandstone at lower 10 cm, with 50% glauconite mineral	62.15	18.99	7.08	0.26	2.43	0.07	5.29	0.05	1.16	0.10

Annexure-15 Geochemical analytical results of core samples, Borehole RKS-7, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Α

Sl.	Sample	San	nple le	ngth	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From	То	Total length	हिंद्र हो।	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
9	KS-7/9	6.50	7.00		Medium to fine grained, cream sandstone with thin band of gray shale, having band glauconitic sandstone at lower 10 cm, with 50% glauconite mineral	87.37	4.87	3.50	0.16	0.84	0.00	1.61	0.03	0.13	0.10
10	KS-7/10	7.00	8.00	1.00	Medium to fine grained, cream sandstone with thin band of gray shale with 5% glauconite grain	93.91	2.34	1.45	0.08	0.24	0.00	0.89	0.01	0.08	0.04
11	KS-7/11	8.00	9.00	1.00	Medium to fine grained, cream sandstone and light brown to yellow shale	69.85	15.82	4.31	0.20	2.02	0.08	4.47	0.05	0.93	0.08
12	KS-7/12	9.00	12.00	3.00	Light brown to yellowish sahle intercalted with thin band of micaceous sandstone	64.93	13.03	12.13	0.41	2.30	0.05	3.48	0.37	0.76	0.11
13	KS-7/13	12.00	15.00	3.00	Light brown to yellowish sahle intercalted with thin band of micaceous sandstone	62.09	11.53	19.43	0.31	1.40	0.03	2.30	0.54	0.62	0.16
14	KS-7/14	15.00	16.00	1.00	Coarse, yellowish to light Gray, massive, poorly sorted sandstone	81.04	8.96	6.32	0.09	0.68	0.01	1.23	0.07	0.40	0.11
15	KS-7/15	16.00	20.00	4.00	Coarse to medium grained cream to light brown massive sandstone	93.20	3.95	1.42	0.05	0.16	0.01	0.38	0.01	0.07	0.03
16	KS-7/16	20.00	21.00	1.00	Light yellowish to Gray shale intercalated with thin band of siltstone	67.60	16.78	6.81	0.13	1.60	0.06	3.66	0.05	0.93	0.08
	KS-7/17	21.00	25.00	4.00	Light yellowish to Gray shale intercalated with thin band of siltstone and brown to light yellow siltstone with minor shale	58.42	14.04	8.30	4.44	3.29	0.07	4.23	0.19	0.72	0.08
18	KS-7/18	25.00	27.50	2.50	Light Gray to brownish shale	67.60	18.12	4.60	0.17	1.89	0.08	3.90	0.05	0.96	0.06

Annexure-15 Geochemical analytical results of core samples, Borehole RKS-7, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl.	Sample	San	nple le	ngth	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length	7751										
19	KS-7/19	27.50	30.00	2.50	Light Gray to brownish shale and medium to	93.68	1.98	3.98	0.04	0.01	0.01	0.08	0.01	0.03	0.03
					fine grained, yellowish brown massive	VA									
					sandstone			110							

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Sl.	Sample	Samı	ole leng	gth (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P ₂ O ₅
No.	ID	From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	KS-8/1	1.00	2.00	1.00	Gray to khaki coloured , micaceous shale	64.61	16.09	5.10	2.55	1.67	< 0.01	4.55	0.03	0.99	0.06
2	KS-8/2	2.00	3.00	1.00	Gray to khaki coloured, micaceous shale	67.17	15.50	5.33	0.80	1.92	0.01	5.37	0.04	0.98	0.06
3	KS-8/3	3.00	4.00	1.00	Gray to khaki coloured , micaceous shale	70.68	14.75	3.46	0.28	1.77	0.01	5.50	0.04	0.92	0.08
4	KS-8/4	4.00	5.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	71.11	15.03	3.25	0.56	1.73	0.03	5.32	0.01	0.95	0.12
5	KS-8/5	5.00	6.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	70.20	15.46	3.67	0.36	1.76	0.03	5.53	0.02	0.93	0.07
6	KS-8/6	6.00	7.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	87.44	5.09	1.60	0.10	0.82	<0.01	2.42	0.05	0.42	0.06
7	KS-8/7	7.00	8.00		Gray to khaki coloured micaceous shale with thin band of sandstone	81.70	8.09	2.34	0.24	1.06	< 0.01	3.28	0.06	0.64	0.10
8	KS-8/8	8.00	9.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	82.57	7.61	3.00	0.31	1.00	<0.01	3.00	0.06	0.55	0.07
9	KS-8/9	9.00	10.00		Gray to khaki coloured micaceous shale with thin band of sandstone	77.07	10.07	3.64	0.28	1.34	< 0.01	4.35	0.15	0.76	0.08

Geochemical analytical results of core samples, Borehole RKS-8, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl.	Sample Sample length (m) Lithology				Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
10	KS-8/10	10.00	11.00		Gray to khaki coloured micaceous shale with thin band of sandstone	75.67	11.01	3.89	0.27	1.46	<0.01	4.74	0.13	0.78	0.10
11	KS-8/11	11.00	12.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	72.39	12.61	4.29	0.33	1.70	<0.01	5.34	0.10	0.83	0.12
12	KS-8/12	12.00	13.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	70.99	11.71	3.90	2.16	1.72	< 0.01	5.00	0.08	0.78	0.11
13	KS-8/13	13.00	14.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	75.01	9.83	3.84	1.45	1.48	<0.01	4.40	0.14	0.72	0.10
14	KS-8/14	14.00	15.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	60.95	12.26	4.27	5.24	3.63	<0.01	4.92	0.09	0.74	0.12
15	KS-8/15	15.00	16.00	1.00	Gray to khaki coloured micaceous shale with thin band of sandstone	62.29	11.88	4.05	4.91	3.33	< 0.01	4.84	0.08	0.74	0.11
16	KS-8/16	16.00	19.00	3.00	Gray to khaki coloured micaceous shale with thin band of sandstone	70.71	12.26	4.21	1.75	1.81	<0.01	5.16	0.09	0.80	0.14
17	KS-8/17	19.00	24.00	5.00	Medium to fine grained, dark gray to light brown sandstone with thin band of shale		11.88	3.30	0.22	1.40	< 0.01	4.78	0.06	0.80	0.09

Geochemical analytical results of core samples, Borehole RKS-8, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl.	Sample	Samp	ole leng	gth (m)	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length											
					Medium to fine grained, dark gray to light brown sandstone with thin band of shale and gray to green	TIE									
18	KS-8/18	24.00	26.00	2.00	shale	66.70	16.76	5.61	0.24	1.68	< 0.01	5.69	0.05	0.93	0.07
19	KS-8/19	26.00	27.00	1.00	Gray to green shale	66.09	16.93	5.60	0.30	1.85	< 0.01	6.02	0.03	0.93	0.10
20	KS-8/20	27.00	28.00	1.00	Gray to green shale	65.67	17.86	5.45	0.28	1.80	< 0.01	6.20	0.03	0.97	0.07
21	KS-8/21	28.00	29.00		Medium to fine grained, gray to light brown sandstone, with thin shale band	62.19	20.32	4.76	0.29	1.95	0.02	6.94	0.02	1.11	0.13

Annexure-17 Geochemical analytical results of core samples, Borehole RKS-9, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl.	Sample	San	nple le	ngth	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	KS-9/1	1.00	2.00	1.00	Khakhi to yellow shale with parting of Maroon shale	67.96	15.37	6.17	0.42	1.55	0.06	4.5	0.06	0.95	0.08
2	KS-9/2	2.00	3.00	1.00	Khakhi to yellow shale with parting of Maroon shale	67.00	14.74	8.08	0.31	1.45	0.01	4.7	0.14	1.00	0.07
3	KS-9/3	3.00	4.00	1.00	Khakhi to yellow shale with parting of Maroon shale	67.14	14.76	8.18	0.28	1.32	<0.01	4.6	0.12	0.91	0.06
4	KS-9/4	4.00	5.00	1.00	Khakhi to yellow shale with parting of Maroon shale	66.73	15.08	7.59	0.27	1.46	<0.01	5.0	0.17	0.94	0.07
5	KS-9/5	5.00	6.00	1.00	Khakhi to yellow shale with parting of Maroon shale	62.94	17.47	9.63	0.27	1.39	<0.01	4.9	0.09	0.92	0.05
6	KS-9/6	6.00	7.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	64.11	16.74	9.81	0.27	1.37	<0.01	4.8	0.12	0.90	0.05
7	KS-9/7	7.00	8.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	64.78	16.78	9.07	0.27	1.42	0.00	5.0	0.16	0.92	0.06
8	KS-9/8	8.00	9.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	62.96	17.02	9.55	0.27	1.45	<0.01	5.2	0.11	0.90	0.07
9	KS-9/9	9.00	10.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	63.68	17.18	8.50	0.31	1.50	<0.01	5.2	0.14	0.91	0.10
10	KS-9/10	10.00	11.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	64.07	16.88	8.97	0.30	1.49	<0.01	5.2	0.18	0.87	0.09
11	KS-9/11	11.00	12.00		Maroon shale with parting of yellow shale, thin band of siltstone	63.78	16.14	9.70	0.35	1.41	<0.01	5.2	0.15	0.85	0.11
12	KS-9/12	12.00	13.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	63.16	15.99	10.16	0.33	1.43	<0.01	5.3	0.12	0.86	0.11

Annexure-17 Geochemical analytical results of core samples, Borehole RKS-9, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl.	Sample	San	nple le	ngth	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From	То	Total length		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
13	KS-9/13	13.00	14.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	65.33	15.96	8.94	0.28	1.35	<0.01	5.1	0.09	0.83	0.10
14	KS-9/14	14.00	15.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	63.10	16.10	10.35	0.29	1.46	<0.01	5.4	0.11	0.84	0.10
15	KS-9/15	15.00	16.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	65.78	15.89	8.59	0.36	1.47	<0.01	5.3	0.09	0.86	0.11
16	KS-9/16	16.00	17.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	63.91	15.78	10.11	0.33	1.47	<0.01	5.4	0.13	0.88	0.11
17	KS-9/17	17.00	18.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	63.76	15.84	9.74	0.32	1.53	<0.01	5.4	0.13	0.84	0.10
18	KS-9/18	18.00	19.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	63.44	15.64	10.31	0.31	1.55	<0.01	5.4	0.15	0.83	0.10
19	KS-9/19	19.00	20.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	65.01	15.81	9.21	0.30	1.58	<0.01	5.4	0.14	0.86	0.10
20	KS-9/20	20.00	21.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	65.09	15.63	9.35	0.29	1.59	<0.01	5.4	0.13	0.88	0.11
21	KS-9/21	21.00	22.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	65.52	15.05	9.65	0.27	1.53	<0.01	5.2	0.22	0.87	0.10
22	KS-9/22	22.00	23.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	64.71	15.64	10.22	0.18	1.26	<0.01	5.0	0.17	0.90	0.10
23	KS-9/23	23.00	24.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	65.09	17.44	10.25	0.13	0.76	<0.01	3.6	0.01	0.99	0.11
24	KS-9/24	24.00	25.00	1.00	Maroon shale with parting of yellow shale, thin band of siltstone	87.83	6.98	3.46	0.04	0.13	<0.01	0.4	0.01	0.93	0.05

Annexure-17 Geochemical analytical results of core samples, Borehole RKS-9, Sapotra-Karauli sub-basin, Karauli district, Rajasthan.

Sl.	Sample	San	nple le	ngth	Lithology	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	Na ₂ O	K ₂ O	MnO	TiO ₂	P_2O_5
No.	ID	From	То	Total		(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
				length											
25	KS-9/25	25.00	29.00	4.00	Medium to fine, light Maroon to cream	83.84	8.42	5.08	0.12	0.13	< 0.01	0.4	0.01	0.62	0.04
					sandstone	. 7	ď								
26	KS-9/26	29.00	30.00	1.00	Medium to fine, light Maroon to cream	84.48	10.13	2.77	0.06	0.09	< 0.01	0.3	0.01	0.80	0.03
					sandstone		-	11							

Details of borehole and summarised litholog of Borehole RKS-1, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-1 Area: Dudupura, Sapotra

Angle: 90°, Azimuth: NA Location: Latitude: 26° 21' 13.8" N

Date of commencement: 22/02/2016

Date of completion: 28/02/2016

R.L. at collar: 283 m

Drilled by unit no.:Outsource

R.L. at bottom: 248.5m

Total depth drilled: 34.50 m

Run Le	ength	Total length	Core recovery	RQD	Structure	Core angle	Lithology
From	То	(m)	(%)	%	-20 11	7	
0.00	1.50	1.5	7	0			Scree of sandstone and siltstone
1.50	3.00	1.5	7	0	SURI	1	Scree of sandstone and siltstone
3.00	4.50	1.5	33	0		CP	Fine grained, cream to reddish siltstone, weathered
4.50	6.00	1.5	7	0		100	Fine grained, cream to reddish siltstone, weathered
6.00	7.50	1.5	53	16	Lamination, fractured		Fine grained, cream to reddish siltstone, weathered
7.50	9.00	1.5	73	0		3	Gray to light green shale with thin band of light maroon shale
9.00	10.50	1.5	47	7		30°	Yellowish to light green shale with thin band of maroon shale.
10.50	12.00	1.5	80	$\stackrel{7}{\Rightarrow}$	Lamination, fractured		Light green to olive shale with thin band of brown shale.
12.00	13.50	1.5	73	17	Lamination fractured	30°	Light green to olive shale with thin band of brown shale and siltstone
13.50	15.00	1.5	80	0	Lamination, fractured		Light green to olive shale with thin band of brown shale and siltstone
15.00	16.50	1.5	73	0	प्रमुख प्र		Light green to olive shale with thin band of brown shale
16.50	18.00	1.5	87	28	Joint	25°	Light green to olive shale with thin band of brown shale
18.00	19.50	1.5	87	19	Fractured		Light green to olive shale with thin band of light red to brown shale
19.50	21.00	1.5	90	13	Lamination		Light green to olive shale with 40% red to brown shale
21.00	22.50	1.5	93	20	Lamination	25°	Maroon to light brown shale with thin bands of light green shale
22.50	24.00	1.5	93	10	Lamination		Maroon to light brown shale with thin bands of light green shale
24.00	25.50	1.5	87	15	Lamination	18°	Maroon to light brown shale with thin bands of light green shale
25.50	27.00	1.5	80	15	Lamination		Maroon to light brown shale with thin bands of light green shale
27.00	28.50	1.5	93	16	Lamination		Light brown shale with thin band of gray shale
28.50	30.00	1.5	93	10	Lamination		Light green shale with bands of maroon shale
30.00	31.50	1.5	67	0	Lamination	18°	Light green shale with bands of maroon shale
31.50	33.00	1.5	93	9	Lamination		Light green shale with bands of maroon shale
33.00	34.50	1.5	47	0			Light green shale with bands of maroon shale

Details of borehole and summarised litholog of Borehole RKS-2, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-2 Area: Ramapura Ghati, Sapotra

Angle: 90°, Azimuth: NA Location: Latitude: 26° 22' 38.7" N

Date of commencement: 02/03/2016 Longitude: 76° 52' 59.9" E

Date of completion: 08/03/2016 R.L. at collar: 290 m

Drilled by unit no.:Outsource R.L. at bottom: 255m

Total depth drilled: 35.0 m

Run Leng		Total length	Core recovery	_ `	Structure	Core Angle	Lithology
From	То	(m)	(%)	(%)			
0.00	1.50	1.50	46.67	0	\cdot \cdot \cdot		Weathered zone, boulders of siltstone and sandstone
1.50	3.00	1.50	53.33	0			Weathered zone, boulders of siltstone and sandstone
3.00	4.50	1.50	63.33	0	Thinly laminated, fractured	30°	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of siltstone
4.50	6.00	1.50	60.00	0	Thinly laminated, fractured	177	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of siltstone
6.00	7.50	1.50	76.67	15	Thinly laminated, fractured		Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of sandstone
7.50	9.00	1.50	93.33	0	Thinly laminated, fractured	28°	Light maroon colour shale with thin parting of yellow shale, intercalated with thin band of sandstone
9.00	10.00	1.00	95.00	0	Thinly laminated		Maroon shale with thin parting siltstone
10.00	11.00	1.00	95.00	0	Thinly laminated		Light maroon colour shale with thin parting of yellow shale
11.00	12.00	1.00	96.00	0	Thinly laminated	3	Light maroon colour shale with thin parting of yellow-green shale
12.00	13.00	1.00	96.00	12	Thinly laminated		Light maroon colour shale, medium to coarse grain, light green, glauconitic (50%) sandstone
13.00	14.00	1.00	96.00	27	Thinly laminated, joint	20°	Medium to coarse grain, light red color sandstone followed by maroon shale
14.00	15.00	1.00	85.00	17	Fractured	20	Medium to fine grained red colour sandstone intercalated with maroon shale
15.00	16.00	1.00	86.00	0	Thinly laminated	20	Light maroon colour shale with thin parting of yellow shale
16.00	17.00	1.00	86.00	0	Thinly laminated		Light maroon colour shale with thin parting of yellow shale
17.00	18.00	1.00	60.00	0	Thinly laminated, fractured		Light maroon colour shale with thin parting of yellow shale
18.00	19.00	1.00	90.00	11	Thinly laminated	18°	Light maroon colour shale with thin parting of yellowish green shale, thin band of sandstone
19.00	20.00	1.00	90.00	0	Thinly laminated		Light brown to yellowish shale with thin band of sandstone
20.00	21.00	1.00	90.00	0	Thinly laminated		Light brown to yellowish shale with thin band of maroon shale
21.00	22.00	1.00	96.00	0	Thinly laminated		Light brown to yellowish shale with thin band of maroon shale
22.00	23.00	1.00	98.00	0	Thinly laminated		Light brown to yellowish shale with thin band of maroon shale
23.00	24.00	1.00	90.00	0	Thinly laminated		Light brown to yellowish shale with thin band of maroon shale
24.00	25.00	1.00	96.00	16	Thinly laminated	18°	Light brown to yellowish shale with thin band of maroon shale

∆nnexure-19

Run Lengt	h (m)	Total length	Core recovery	RQD	Structure	Core Angle	Lithology
From	To	(m)	(%)	(%)			
25.00	26.00	1.00	96.00	0	Thinly laminated		Light brown to yellowish shale with thin band of olive shale
26.00	27.00	1.00	96.00	0	Thinly laminated		Light brown to yellowish shale with thin band of olive shale
27.00	28.00	1.00	98.00	0	Thinly laminated		Olive green shale with thin bands of cream shale
28.00	29.00	1.00	98.00	0	Thinly laminated	16°	Olive green to light yellow shale with thin bands of maroon shale
29.00	30.00	1.00	98.00	0	Thinly laminated		Olive green to light yellow shale with thin bands of maroon shale
30.00	31.00	1.00	98.00	0	Thinly laminated		Olive green to light yellow shale with thin bands of maroon shale
31.00	32.00	1.00	98.00	24	Thinly laminated		Olive green to light yellow shale with thin bands of maroon shale
32.00	33.00	1.00	98.00	25	Thinly laminated	18°	Olive green to light yellow shale with thin bands of maroon shale
33.00	34.00	1.00	98.00	10	Thinly laminated	20	Olive green to light yellow shale with thin bands of maroon shale
34.00	35.00	1.00	98.00	10	Thinly laminated	S.U.	Olive green to light yellow shale with thin bands of maroon shale



Details of borehole and summarised litholog of Borehole RKS-3, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-3 Area: Dauljipura, Sapotra

Angle: 90°, Azimuth: NA Location: Latitude: 26° 18' 24.1" N

Date of commencement: 12/03/2016 Longitude: 76° 48' 39.5" E

Date of completion: 18/03/2016 R.L. at collar: 289 m

Drilled by unit no.: Outsource R.L. at bottom: 258.5

Total depth drilled: 30.50 m

Run Len	gth (m)	Total length	Recovery	RQD	Structure	Core angle	Lithology
From	То	(m)	%	%			
0.00	1.00	1.00	50	0			Overburden, fragment of sandstone and siltstone
1.00	2.00	1.00	50	0			Overburden, fragment of sandstone and siltstone
2.00	3.00	1.00	30	0			Overburden, fragment of sandstone and siltstone
3.00	4.00	1.00	98	51	lamination, fractured	20°	Fine to medium grained, light Brownish sandstone
4.00	5.00	1.00	98	30	joint, fractured	4 4	Fine to medium grained, light brownish, sandstone and siltstone
5.00	6.00	1.00	90	0	3 U F	1/2	Light Brownish to maroon shale inntercalated with thin bands of olive shale and siltstone
6.00	7.00	1.00	95	0		- 4	Light Brownish to maroon shale inntercalated with thin bands of olive shale and siltstone
7.00	8.00	1.00	98	25		18°	Light Brownish shale intercalated with thin band of siltstone
8.00	9.00	1.00	98	15		A.	Light Brownish shale intercalated with thin band of siltstone and olive shale
9.00	10.00	1.00	98	12	jointed, laminated		Light Brownish shale intercalated with thin band of olive shale
10.00	11.00	1.00	98	10	Laminated, fractured		Brownish to maroon shale with thinly laminated olive shale
11.00	12.00	1.00	96	10	TIM	7	Brownish to maroon shale with thinly laminated olive shale
12.00	13.00	1.00	95	0	fractured	18°	Brownish to maroon shale with thinly laminated olive shale
13.00	14.00	1.00	95	10			Brownish to maroon shale with thinly laminated olive shale
14.00	15.00	1.00	98	0			Brownish to light yellow shale with thinly laminated olive shale
15.00	16.00	1.00	98	0	Thinly laminated	15°	Brownish to light yellow shale with thinly laminated olive shale
16.00	17.00	1.00	98	0	laminated		Brownish to light yellow shale with thinly laminated olive shale
17.00	18.00	1.00	98	11	Thinly laminated		Brownish to light yellow shale with thinly laminated olive shale
18.00	19.00	1.00	98	23	57	77	Olive to brownish sahle with thin band of maroon sahle
19.00	20.00	1.00	98	0	fractured	22°	Olive to brownish sahle with thin band of maroon sahle
20.00	21.00	1.00	96	37			Olive to brownish sahle with thin band of maroon sahle
21.00	22.00	1.00	96	12	fractured		Olive to brownish sahle with thin band of maroon sahle
22.00	23.00	1.00	98	30		18°	Olive to brownish sahle with thin band of maroon sahle
23.00	24.00	1.00	98	24	fractured		Olive to brownish sahle with thin band of maroon sahle
24.00	25.00	1.00	98	11			Olive to brownish sahle with thin band of maroon sahle
25.00	26.00	1.00	98	10	lower part is fractured		Olive to brownish sahle with thin band of maroon sahle
26.00	27.00	1.00	98	51	upper fractured		Olive to brownish sahle,Intercalation of sandstone and thinly laminated glauconitic sandstone
27.00	28.00	1.00	98		fractured		Brownish to olive sahle
28.00	29.00	1.00	98	11	fractured	15°	Brownish to olive sahle
29.00	30.00	1.00	97	-	fractured		Brownish to olive sahle
30.00	30.50	0.50	60	20	fractured		Brownish to olive sahle

Details of borehole and summarised litholog of Borehole RKS-4, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-4 Area: Bapoti, Sapotra

Angle: 90°, Azimuth: NA Location: Latitude: 26° 18' 20.8" N

Date of commencement: 20/03/2016 Longitude: 76° 45' 41.4" E

Date of completion: 26/03/2016 R.L. at collar: 267 m

Drilled by unit no.: Outsource R.L. at bottom: 237m

Total depth drilled: 30.0 m

Run	Length	(m)	Recovery	RQD	Core angle	Lithology
From	То	Total length	%	%		
0.00	1.00	1.00	71.0	0	3 5 5	Overburden, fine to medium grained, cream coulur sandstone
1.00	2.00	1.00	84.0	0	IЪ	Fine to medium grained, cream coulur sandstone
2.00	3.00	1.00	97.0	0		Brownish to yellow shale with thinly laminated gary gay shale
3.00	4.00	1.00	98.0	0		Brownish to yellow shale with thinly laminated gary gay shale
4.00	5.00	1.00	90.0	0	8°	Brownish to yellow shale with thinly laminated gary gay shale
5.00	6.00	1.00	98.0	0		Brownish to yellow shale with thinly laminated gary gay shale
6.00	7.00	1.00	98.0	0		Brownish to yellow shale with thinly laminated gary gay shale
7.00	8.00	1.00	98.0	0		Brownish to yellow shale with thinly laminated gary gay shale
8.00	9.00	1.00	95.0	0	8°	Grey to light brown shale
9.00	10.00	1.00	98.0	24		Grey to light brown shale
10.00	11.00	1.00	96.00	0		Grey to light brown shale
11.00	12.00	1.00	98.0	11	नेव ज	Brownish to yellow shale with thinly laminated gary gay shale
12.00	13.00	1.00	95.0	0		Grey to light brown shale
13.00	14.00	1.00	90.0	0	10°	grey to brownish
14.00	15.00	1.00	97.0	10		Brownish to yellow shale with thinly laminated gary gay shale
15.00	16.00	1.00	90.0	0	N ØX	Grey to light brown shale
16.00	17.00	1.00	95.0	0	10°	Olive to light brown shale
17.00	18.00	1.00	96.0	0		Light brown to light green shale
18.00	19.00	1.00	98.0	11		Light brown to light green shale
19.00	20.00	1.00	96.0	0		Light brown to light green shale
20.00	21.00	1.00	95.0	0		Light brown to light green shale
21.00	22.00	1.00	90.0	0	10°	Light brown to light green shale
22.00	23.00	1.00	90.0	11		Light brown to light green shale
23.00	24.00	1.00	90.0	0		Light brown to light green shale
24.00	25.00	1.00	90.0	10		Light brown to light green shale
25.00	26.00	1.00	90.0	0	8°	Olive-grey shale with thin bands of brownish shale
26.00	27.00	1.00	98.0	28		Olive-grey shale with thin bands of brownish shale
27.00	28.00	1.00	98.0	0		Olive-grey shale with thin bands of brownish shale
28.00	29.00	1.00	98.0	0		Olive-grey shale with thin bands of brownish shale
29.00	30.00	1.00	100.0	0		Olive-grey shale with thin bands of brownish shale

Details of borehole and summarised litholog of Borehole RKS-5, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-5 Area: Gothra, Sapotra

Angle: 90° , Azimuth: NA Location: Latitude: 26° 19' 10.8" N Date of commencement: 31/03/2016 Longitude: 76° 47' 38.4" E Date of completion: 07/04/2016 R.L. at collar: 268 m

Date of completion: 07/04/2016 R.L. at collar: 268 m

Drilled by unit no.: Outsource R.L. at bottom: 223m

Total depth drilled: 45.0 m

Ru	ın Length	(m)	Core	RQD	Structure	Core angle	Lithology
From	То	Total length	%	%	JRV		
0.00	1.00	1.00	10.0	0	- 4		Overburden, sandstone
1.00	2.00	1.00	80.0	0			Overburden, sandstone and shale
2.00	3.00	1.00	52.0	0			Overburden, sandstone/shale
3.00	4.00	1.00	93.0	0	weathered		Brownish to grey shale
4.00	5.00	1.00	92.0	0	weathered		Olive grey with thin bands of brown shale
5.00	6.00	1.00	93.0	0	weathered	23°	Grey to light green shale with thin band of siltstone at places
6.00	7.00	1.00	96.0	2 11	weathered		Grey to light green shale with thin band of siltstone at places
7.00	8.00	1.00	95.0	0	weathered	1 13	Grey to light green shale with thin band of siltstone at places
8.00	9.00	1.00	97.0	0	jointed, laminated	23°	Grey to light green shale with thin band of siltstone at places
9.00	10.00	1.00	97.0	0	jointed, laminated		Grey to light green shale with thin band of siltstone at places
10.00	11.00	1.00	98.00	12	jointed, laminated		Grey to light green shale with thin band of siltstone at places
11.00	12.00	1.00	96.0	11	jointed, laminated	23°	Grey to light green shale with thin band of siltstone at places
12.00	13.00	1.00	98.0	0	jointed, laminated		Grey to light green shale with thin band of siltstone at places
13.00	14.00	1.00	98.0	10	jointed, laminated		Grey to light green shale with thin band of siltstone at places
14.00	15.00	1.00	98.0	13	Laminated	23°	Grey to light green shale with thin band of siltstone at places
15.00	16.00	1.00	96.0	14	Laminated		Grey to light green shale with thin band of siltstone at places
16.00	17.00	1.00	97.0	16	Laminated		Grey to light green shale with thin band of glaucomitic sandstone 40 cm
17.00	18.00	1.00	98.0	0	Laminated		Grey to light green shale with top 50 cm is glauconitic sandstone
18.00	19.00	1.00	98.0	0	Laminated		Grey to light green shale with thin band of siltstone at places
19.00	20.00	1.00	98.0	0	Laminated	23°	Grey to light green shale with thin band of siltstone at places
20.00	21.00	1.00	98.0	10	Laminated		Grey to light green shale with thin band of siltstone at places
21.00	22.00	1.00	97.0	0	Laminated		Grey to light green shale

R	un Length	(m)	Core	RQD	Structure	Core	Lithology
			recovery			angle	
From	То	Total	%	%			
		length					
22.00	23.00	1.00	98.0	12	Laminated		Grey to light green shale
23.00	24.00	1.00	98.0	56	Laminated		Grey to light green shale
24.00	25.00	1.00	98.0	14	Laminated		Grey to light green shale
25.00	26.00	1.00	98.0	34	Laminated		Grey to light green shale
26.00	27.00	1.00	98.0	30	Laminated	21°	Grey to light green shale
27.00	28.00	1.00	98.0	28	Laminated		Grey to light green shale
28.00	29.00	1.00	98.0	31	Laminated		Grey to light green shale
29.00	30.00	1.00	98.0	37	Laminated		Grey to light green shale
30.00	31.00	1.00	97.0	10	Laminated		Grey to light green shale
31.00	32.00	1.00	98.0	41	Laminated		Grey to light green shale
32.00	33.00	1.00	98.0	31	Laminated		Olive green to dark grey shale
			/ 3		jointed,		
33.00	34.00	1.00	95.0	0	fractured		Olive green to dark grey shale
34.00	35.00	1.00	98.0	25	jointed	1	Olive green to dark grey shale
35.00	36.00	1.00	98.0	77	Laminated	21°	Olive green to dark grey shale
36.00	37.00	1.00	98.0	72	Laminated		Olive green to dark grey shale
37.00	38.00	1.00	98.0	53	Laminated		Olive green to dark grey shale
38.00	39.00	1.00	98.0	87	Laminated		Olive green to dark grey shale
39.00	40.00	1.00	95.0	32	Laminated		Olive green to dark grey shale
	- /	b//	\circ		Fractured,		-1001
40.00	41.00	1.00	98.0	21	jointed		Olive green to dark grey shale
41.00	42.00	1.00	98.0	62	jointed		Olive green to dark grey shale
42.00	43.00	1.00	98.0	<u></u>	Laminated	21°	Olive green to dark grey shale
43.00	44.00	1.00	98.0	30	Laminated)/EX	Olive green to dark grey shale
44.00	45.00	1.00	98.0	47	jointed	A	Olive green to dark grey shale

Details of borehole and summarised litholog of Borehole RKS-6, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-6 Area: Kaontipura, Sapotra

Location: Latitude: 26° 17' 0.7" N Angle: 90°, Azimuth: NA Date of commencement: 10/04/2016 Longitude: 76° 44' 35.8" E Date of completion: 15/04/2016 R.L. at collar: 258 m R.L. at bottom: 228m Drilled by unit no.: Outsource

Total depth drilled: 30.0 m

R	tun Len	ngth	Core recovery	RQD	Structure	Core angle	Lithology
From	То	Total length	%	%			
					ZIII		Overburden, fragment of coarse grained, light brown to cream coloured
0.00	1.00	1.00	0.46	0		0	sandstone
			- 6		Highly weathered	V 10	
1.00	2.00	1.00	90	0	and fractured		Light brown to redish shale
					Highly weathered	300	
2.00	3.00	1.00	95	0	and fractured	12°	Light brown to redish shale
3.00	4.00	1.00	92	0	Highly weathered and fractured		Light brown to redish shale
	13	0/1	9	1			\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \
4.00	5 00	1.00	0.5	0	Moderatly weathered		
4.00	5.00	1.00	95	0	& fractured		Grey to light brown shale
					Moderatly weethered		
5.00	6.00	1.00	94	A10	Moderatly weathered & fractured	A	Grey to light brown shale
6.00	7.00	1.00	94		Moderatly fractured	7/2	Grey to light brown shale
7.00	8.00	1.00	90		jointed		Grey to light brown shale
8.00	9.00	1.00	92		jointed	1	Light yellow to grey shale
0.00	2.00	1.00	72	13	Jointed	1	Light yellow to grey shale with thin
9.00	10.00	1.00	95	35	jointed	12°	band of sandstone
7.00	10.00	1.00	,	33	lower part is highly	12	Light yellow to grey shale with thin
10.00	11.00	1.00	90	0	weathered/fractured		band of sandstone
10.00	11.00	1.00	70		upper part is	7	Light yellow to grey shale with thin
11.00	12.00	1.00	90	0	weathered/fractured		band of sandstone
			77///	1111		1990 C	Light yellow to grey shale with thin
12.00	13.00	1.00	90	0	fractured		band of sandstone
13.00	14.00	1.00	92	33	jointed	7	Light yellow to grey shale
14.00	15.00	1.00	95	57	jointed		Light yellow to grey shale
							Light yellow to grey shale with thin
15.00	16.00	1.00	90	14	jointed		band of sandstone
							Light yellow to grey shale with thin
16.00	17.00	1.00	98	76			lamination of brown shale
							Light yellow to grey shale with thin
17.00	18.00	1.00	98	11	laminated	12°	lamination of brown shale
							Light yellow to grey shale with thin
18.00	19.00	1.00	98	52	laminated		lamination of brown shale
							Light yellow to grey shale with thin
19.00	20.00	1.00	98	31	fractured		lamination of brown shale
							Light yellow to grey shale with thin
20.00	21.00	1.00	98	47	jointed		lamination of brown shale
							Light yellow to grey shale with thin
21.00	22.00	1.00	98	20	20 cm fractured zone		lamination of brown shale
22.00	22.00	1.00	0.0				Light yellow to grey shale with thin
22.00	23.00	1.00	98	41			lamination of brown shale
22.00	24.00	1.00	00	25			Light yellow to grey shale with thin
23.00	24.00	1.00	98	37			lamination of brown shale
24.00	25.00	1.00	0.0	~-		120	Light yellow to grey shale with thin
24.00	25.00	1.00	98	25		12°	lamination of brown shale
25.00	26.00	1.00	00	2.1			Light yellow to grey shale with thin
25.00	26.00	1.00	98	21			lamination of brown shale

F	Run Le	ngth	Core recovery	RQD Structure		Core angle	Lithology
From	То	Total length	%	%			
0.00	1.00	1.00	0.46	0			Overburden, fragment of coarse grained, light brown to cream coloured sandstone
26.00	27.00	1.00	98	29			Light yellow to grey shale with thin lamination of brown shale
27.00	28.00	1.00	98	28	jointed		Light yellow to grey shale with thin lamination of brown shale
28.00	29.00	1.00	95		lower part is fractured	12°	Light yellow to grey shale with thin lamination of brown shale
29.00	30.00	1.00	98	53			Light brown to red



Details of borehole and summarised litholog of Borehole RKS-7, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-7 Area: Garain Ki Gwari, Sapotra

Angle: 90°, Azimuth: NA Location: Latitude: 26° 21' 59.4" N

Date of commencement: 18/04/2016 Longitude: 76° 49' 44.1" E

Date of completion: 23/04/2016 R.L. at collar: 270 m

Drilled by unit no.: Outsource R.L. at bottom: 240m

Total depth drilled: 30.0 m

R	tun Leng	jth	Core recovery	RQD	RQD Structure Core angle		Lithology
From	То	Total length	%	%			2 2
0.00	1.00	1.00	35.0	0	Laminated		Medium grained, cream to light brown sandatone, glauconite varies from 2 to 5%
1.00	2.00	1.00	100.0	25	Laminated, jointed	7°-10°	Medium grained, cream to light brown sandatone, glauconite varies from 10 to 15%
2.00	3.00	1.00	94.0	0	fractured, weathred		Medium grained, cream to light brown sandatone, glauconite varies from 1 to 2%, lower part yellow shale
3.00	4.00	1.00	98.0	0	fractured, weathred		Grey to light green shale
4.00	5.00	1.00	98.0	0	jointed	TO S	Medium grained, grey to light brown sandstone, with 40 cm band of grey shale
5.00	6.00	1.00	98.0	0			Medium to coarse grained, grey sandstone, top 20 cm having glauconite 30% along lamination planes, thin band of grey shale
6.00	7.00	1.00	98.0	0			Medium to fine grained, cream sandstone with thin band of gray shale, having band glauconitic sandstone at lower 10 cm, with 50% glauconite mineral
7.00	8.00	1.00	97.0	12			Medium to fine grained, cream sandstone with thin band of gray shale with 5% glauconite grain
8.00	9.00	1.00	98.0	0			Medium to fine grained, cream sandstone and light brown to yellow shale

R	tun Leng	th	Core recovery	RQD	Structure	Core angle	Lithology
From	То	Total length	%	%			
9.00	10.00	1.00	98.0	0	Highly fractured		Llight brown to yellow shale
10.00	11.00	1.00	98.0	28	jointed		Light brown to yellowish sahle intercalted with thin band of sandstone, micaceous
11.00	12.00	1.00	92.0	0		Fe content	Light brown to yellowish sahle intercalted with thin band of sandstone, micaceous
12.00	13.00	1.00	90.0	12	33	Fe content	Light brown to yellowish sahle intercalted with thin band of sandstone, micaceous
13.00	14.00	1.00	90.0	10	fractured	50	Light brown to yellowish sahle intercalted with thin band of sandstone, micaceous
14.00	15.00	1.00	90.0	14	jointed		Light brown to yellowish sahle intercalted with thin band of sandstone, micaceous
15.00	16.00	1.00	95.0	0	fractured fractured.	limonitic	coarse, yellowish to light grey, massive, poorly sorted sandstone
16.00	17.00	1.00	98.0	27	jointed		Coarse to medium grained cream to light brown massive sandstone
17.00	18.00	1.00	97.0	41	Fractured		Coarse to medium grained cream to light brown massive sandstone
18.00	19.00	1.00	98.0	37		A SALES	Coarse to medium grained cream to light brown massive sandstone
19.00	20.00	1.00	98.0	45	jointed, fractured		Coarse to medium grained cream to light brown massive sandstone
20.00	21.00	1.00	98.0	39			Light yellowish to grey shale intercalated with thin band of siltstone Light yellowish to grey shale intercalated with
21.00	22.00	1.00	97.0	28	jointed	/15	thin band of siltstone
22.00	23.00	1.00	97.0	23	Laminated		Light yellowish to grey shale intercalated with thin band of siltstone
23.00	24.00	1.00	98.0	45	Laminated thin sand		Brown to light yellow siltstone with minor shale
24.00	25.00	1.00	98.0	33	lense Fractured,		Brown to light yellow siltstone with minor shale
25.00	26.00	1.00	92.0		weathered		Light grey to brownish shale
26.00	27.00	1.00	97.0	11	Fractured		Light grey to brownish shale Light grey to brownish shale, lower 40 com is
27.00	28.00	1.00	98.0	45	fractured,e		sanstone
28.00	29.00	1.00	99.0	28	jointed		Medium to fine grained, yellowish to brownish, massive sandstone
29.00	30.00	1.00	99.0	43	Fractured	7°-10°	medium to fine grained, yellowish brown , massive sandstone

Details of borehole and summarised litholog of Borehole RKS-8, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-8 Area: Langrapura, Sapotra

Angle: 90°, Azimuth: NA Location: Latitude: 26° 23' 39.6" N

Date of commencement: 24/04/2016 Longitude: 76° 52' 30.8" E

Date of completion: 02/05/2016 R.L. at collar: 298 m

Drilled by unit no.: Outsource R.L. at bottom: 268m

Total depth drilled: 30.0 m

Ru	n Length		Core recovery	RQD	Structure	Core angle	Lithology
From	To	Total length	%	%			
							Coarse grained, cream sandstone with 5%
0.00	1.00	1.00	51.0	0	Highly		glauconite
1.00	2.00	1.00	95.0	0	weathered		Grey to khaki coloured , micaceous shale
2.00	3.00	1.00	95.0	0			Grey to khaki coloured , micaceous shale
				17	Laminated, Highly weathered, iron stains	51 /	793
3.00	4.00	1.00	98.0	0	along joint plains	6°-10°	Grey to khaki coloured , micaceous shale
0.00	1.00	1.00	00.0		Laminated,	0 10	Grey to khaki coloured micaceous shale with thin
4.00	5.00	1.00	98.0	0	fractured		band of sandstone
5.00	6.00	1.00	98.0	0	Laminated, fractured, jointed		Grey to khaki coloured micaceous shale with thin band of sandstone
6.00	7.00	1.00	98.0	0	Laminated		Grey to khaki coloured micaceous shale with thin band of sandstone
5.00	7.00	1.00	30.0		Laminated,		Grey to khaki coloured micaceous shale with thin
7.00	8.00	1.00	96.00	0	fractured	WEN.	band of sandstone
8.00	9.00	1.00	98.0	n	Laminated, fractured	6°-10°	Grey to khaki coloured micaceous shale with thin band of sandstone
0.00	0.00		00.0	92	7)	0 10	Grey to khaki coloured micaceous shale with thin
9.00	10.00	1.00	98.0	0	Laminated	K234_42	band of sandstone
10.00	11.00	1.00	98.0	0	Laminated, weathered, fractured		Grey to khaki coloured micaceous shale with thin band of sandstone
	\rightarrow	- N			196	7	Grey to khaki coloured micaceous shale with thin
11.00	12.00	1.00	98.0	0	Laminated	1 भाव	band of sandstone Grey to khaki coloured micaceous shale with thin
12.00	13.00	1.00	98.0	35	Laminated	6°-10°	band of sandstone
13.00	14.00	1.00	98.0	18	Laminated	0.5	Grey to khaki coloured micaceous shale with thin band of sandstone
14.00	15.00	1.00	98.0	0	Laminated	50	Grey to khaki coloured micaceous shale with thin band of sandstone
15.00	16.00	1.00	98.0	57	Laminated		Grey to khaki coloured micaceous shale with thin band of sandstone
16.00	17.00		98.0				Grey to khaki coloured micaceous shale with thin band of sandstone
17.00	18.00	1.00	98.0	0			Grey to khaki coloured micaceous shale with thin band of sandstone
17.00	10.00	1.00	00.0				Grey to khaki coloured micaceous shale with thin
18.00	19.00	1.00	98.0	0			band of sandstone
19.00	20.00	1.00	98.0	0	Zone of brecciation, 3 to 4 cms		Medium to fine grained, dark grey to light brown sandstone with thin band of shale
20.00	21.00	1.00	98.0	14	Zone of brecciation,		Medium to fine grained, dark grey to light brown sandstone with thin band of shale
21.00	22.00	1.00	98.0	0	Zone of brecciation,		Medium to fine grained, dark grey to light brown sandstone with thin band of shale
22.00	23.00	1.00	98.0	25		6°-10°	Medium to fine grained, dark grey to light brown sandstone with thin band of shale
23.00	24.00	1.00	98.0		brecciated upto 24.20 cm.	- 10	Medium to fine grained, dark grey to light brown sandstone with thin band of shale
24.00	25.00	1.00	98.0				Medium to fine grained, dark grey to light brown sandstone with thin band of shale
25.00	26.00	1.00	98.0	0			Gark to green shale
26.00	27.00	1.00	98.0	0			Gark to green shale
27.00	28.00	1.00	98.0	0			Gark to green shale
28.00	29.00	1.00	98.0				Gark to green shale

R	Run Length Co			RQD	Structure	Core	Lithology
						angle	
		Total				-	
From	To	length	%	%			
							Medium to fine grained, grey to light brown
29.00	30.00	1.00	98.0			6°-10°	sandstone, with thin shale band



Details of borehole and summarised litholog of Borehole RKS-9, Sapotra-Karauli sub-basin , Karauli district, Rajasthan

Borehole No. RKS-9 Area: Garain, Sapotra

Angle: 90°, Azimuth: NA Location: Latitude: 26° 20' 54.7" N

Date of commencement: 04/05/2016 Longitude: 76° 48' 35" E

Date of completion: 08/05/2016 R.L. at collar: 256 m

Drilled by unit no.: Outsource R.L. at bottom: 221m

Total depth drilled: 35.0 m

]	Run Leng	th	Core recovery	RQD	Structure	Core angle	Lithology
From	То	Total length	%	%			
0.00	1.00	1.00	32.0	0	Weathered zone		Overburden, soil and boulder of sandstone
1.00	2.00	1.00	84.0	0	Fractured		Khakhi to yellow shale with oarting of Maroon shale
2.00	3.00	1.00	90.0	0	Fractured	IDi	Khakhi to yellow shale with oarting of Maroon shale
3.00	4.00	1.00	94.0	0	. 0	A 14 P	Khakhi to yellow shale with oarting of Maroon shale
4.00	5.00	1.00	94.0	0			Khakhi to yellow shale with oarting of Maroon shale
5.00	6.00	1.00	90.0	0	highly weathered	377a-	Khakhi to yellow shale with oarting of Maroon shale
6.00	7.00	1.00	95.0	0	-O-m	20°	Maroon shale with parting of yellow shale, thin band of siltstone
7.00	8.00	1.00	95.0	0	₹. 1		Maroon shale with parting of yellow shale, thin band of siltstone
8.00	9.00	1.00	96.0	0	fractured		Maroon shale with parting of yellow shale, thin band of siltstone
9.00	10.00	1.00	98.00	0	fractured		Maroon shale with parting of yellow shale, thin band of siltstone
10.00	11.00	1.00	96.0	0	fractured	7911	Maroon shale with parting of yellow shale, thin band of siltstone
11.00	12.00	1.00	98.0	0	9	773	Maroon shale with parting of yellow shale, thin band of siltstone
12.00	13.00	1.00	98.0	0			Maroon shale with parting of yellow shale, thin band of siltstone
13.00	14.00	1.00	98.0	0		20°	Maroon shale with parting of yellow shale, thin band of siltstone
14.00	15.00	1.00	98.0	0	1/m		Maroon shale with parting of yellow shale, thin band of siltstone
15.00	16.00	1.00	98.0	0	Your	XX	Maroon shale with parting of yellow shale, thin band of siltstone
16.00	17.00	1.00	98.0	0	3.9	मव जुड़	Maroon shale with parting of yellow shale, thin band of siltstone
17.00	18.00	1.00	98.0	0	Fractured		Maroon shale with parting of yellow shale, thin band of siltstone
18.00	19.00	1.00	98.0	0	Fractured	851	Maroon shale with parting of yellow shale, thin band of siltstone
19.00	20.00	1.00	98.0	0	1 Julian		Maroon shale with parting of yellow shale, thin band of siltstone
20.00	21.00	1.00	98.0	0	22// 01/22		Maroon shale with parting of yellow shale, thin band of siltstone
21.00	22.00	1.00	98.0	16	£-2375	000	Maroon shale with parting of yellow shale, thin band of siltstone
22.00	23.00	1.00	98.0	21		000	Maroon shale with parting of yellow shale, thin band of siltstone
23.00	24.00	1.00	96.0	30	Laminated		Maroon shale with parting of yellow shale, thin band of siltstone
24.00	25.00	1.00	96.0	15			Maroon shale with parting of yellow shale, thin band of siltstone
25.00	26.00	1.00	98.0	0			Medium to fine, light brown to cream sandstone
26.00	27.00	1.00	96.0	70			Medium to fine, light brown to cream sandstone
27.00	28.00	1.00	96.0	40			Medium to fine, light brown to cream sandstone
28.00	29.00	1.00	96.0	44			Medium to fine, light brown to cream sandstone
29.00	30.00	1.00	98.0	75	Laminated		Medium to fine, light brown to cream sandstone
30.00	31.00	1.00	98.0	0			Medium to fine, light brown to cream sandstone
30.00	30.50	0.50	0.0	66			Medium to fine, light brown to cream sandstone
30.50	31.00	0.50	0.0	38			Medium to fine, light brown to cream sandstone
31.00	32.00	1.00	98.0	42	Fractured		Medium to fine, light brown to cream sandstone
32.00	33.00	1.00	98.0	49	Fractured		Medium to fine, light brown to cream sandstone
33.00	34.00	1.00	90.0	59		20°	Medium to fine, light brown to cream sandstone
34.00	35.00	1.00	98.0	82			Medium to fine, light brown to cream sandstone

Annexure -27

Details of resource calculation by Cross Section method considering 4.50 % cut off grade of $\ K_2O$

S.No	Borehole no.	Zone	1 ^	ong	Width of zone along borehole (m)	True thickness	1		(K ₂ O %)	1 *	Strike length(m)	S.G of host rock	Tonnage (tones)	Tonnage X Grade (K ₂ O)
1	RKS-1	Zone-1	6	33.75		24.50	277	248	5.72	50	5300	2.5	16231250.00	92842750.00
2	RKS-2	Zone-I	3	35	32	28.25	287	255	5.38	50	3000	2.5	10593750.00	56994375.00
3	RKS-3	Zone-I	6	30.5	24.5	23.30	282	257.5	5.14	50	4000	2.5	11650000.00	59881000.00
4	RKS-4	Zone-I	5	30	25	24.75	254	229	5	50	500	2.5	1546875.00	7734375.00
5	RKS-5	Zone-I	4	45	41	38.01	242	201	4.99	50	1600	2.5	7602000.00	37933980.00
6	RKS-6	Zone-I	3	30	27	25.43	247	220	4.88	50	1000	2.5	3178750.00	15512300.00
7	RKS-8	Zone-I	1	6	5	4.95	296	291	5.21	50	500	2.5	309375.00	1611843.75
		Zone-II	10	29	19	18.81	281	262	5.21	50	500	2.5	1175625.00	6125006.25
8	RKS-9	Zone-I	1	30	23	20.66	248	225	5.11	50	2000	2.5	5165000.00	26393150.00

 Total (tones)
 57452625.00

 Total (Million tones)
 57.45

 Average Grade (%)
 5.30

APPENDIX-I

INFORMATION SHEET FOR BIBLIOGRAPHY DATA BASE IN UNPUBLISHED REPORTS.

TITL Title of the report: Preliminary search of potash in glauconitic sandstone/shale of Vindhyan Supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan.

AUTH Name of author (s): Mukesh Kumar Mandal., Senior Geologist

Joy.S, Geologist

TDOC Type of document: Final report

Fill in any one of the following:

Final report, Interim report, General report, Preliminary report, Preconstruction report, Post construction report, Construction report.

CONF Identification of the confidentiality of the report: General

Fill in any one of the following: General

Secret/Confidential/Classified/Restricted/Open/General/

Unclassified

CORP Corporate body (ies):

Fill in name of the following from where report is being issued

Region: SU: Rajasthan, Western Region

Division/Project: Project: FM (Fertilizer Minerals)

RENE Name of the beneficiary of the study when GSI has worked for

some external organisations or ministries: Not applicable

DCNU Document Number: ME/WR/RAJ/2015/049

{**Item no.56** as it appears in the Annual Programme-FSP}

FSPR Field Season Programme Year: 2015-16

APPENDIX-I

DPUB Date of publication of the document: November, 2016

{Year and month only}

ABSI Concise abstract of the document restricted to 2000 characters

(inclusive of blank spaces):

Included in the Report.

MPRF Mapping reference:

Toposheet (s) No: 54B11, 54B12 and 54B15.

Landsat Scene (s) No. if any: NO

DETAILS OF THE WORK INPUT

A. Title of the Report: Preliminary search of potash in glauconitic sandstone/shale of Vindhyan Supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan.

Number of days spent in field by the Geologists:

Name of officers	F.S.2014-15	
Mukesh Kumar Mandal, Senior Geologist		
15.06.2015 and 18.05.2016.	144-days	
(Project-In)		
Joy.S, Geologist		
29.02.2016 and 02.05.2016.	55-days	
(Additional work)		

- C. Distance of operational area from Head Quarters: 180 km (Approx.)
- **D. Mapping:** i). 150 Sq. km Large scale mapping on 1:12,500 scale.
- **E. Drilling:** A total of 300m scout drilling completed in 09 nos. of boreholes (RKS-1 to RKS-9).

F. Laboratory Analysis:

Nature of analysis: XRF (Major Oxides/mainly for Potash (K₂O) analysis).

Sl. No.	Samples	F.S.2014-15
1	Bed Rock Samples	323Nos.
2	Pitting/Trenching	80 Nos.
3	Core Samples	255 Nos.
		Total = 658 Nos.

FIVE POINT PERFORMA

Title of the report:

Preliminary search of potash in glauconitic sandstone/shale of Vindhyan Supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan.

Name of the author(s):

Mukesh Kumar Mandal., Geologist

Joy.S, Geologist

whose instance or with what particular objective in view the investigation was undertaken.

Background of the investigation at To search and delineate glauconitic litho units in Sapotra-Karauli sub basin of Vindhyan Supergroup.

Whether the item of investigation was included in the approved programme for the year concerned. If so, particulars, such as item No., page reference etc. may be given.

Yes, ME/WR/RAJ/2015/049. Item no.56

Date of commencement of the June, 2015 (15.06.2015) investigation with month and year, For FSP: 2015-16 the officer(s) in the field in Joy.S, Geologist-55 days connection with the investigation.

and exact number of days spent by Mukesh Kumar Mandal., Geologist- 144 days

Supervisory officer on the recommendations made by the authors. conclusion and recommendation by the author(s) with suggestion for implementing the same.

Brief comments by Director / I fully agree with the conclusions drawn and

objective for which it was and Taragarh Formations. undertaken

Please state specifically how the The objective of this investigation is fully achieved results of the investigation were by proving surface as well as sub-surface continuity achieved compared with the of glauconite bearing shale/sandstone in Panna, Jhiri

Place: Jaipur

Date: 30 . 11, 16

Signature: Name:

Designation: Director

Project/ Division: Fertilizer Minerals Division S. U./Region: State Unit: Rajasthan, Western Region



Geological Survey of India

Data sheet on report movement in connection with its scrutiny

Project/Division: Project: FM, FSP-2014-15. Item code no: ME/WR/RAJ/2015/049. Mission: II Title of the report: Preliminary search of potash in glauconitic sandstone/shale of Vindhyan Supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan.

Name of author(s)	Date of submission of report to the Supervisory Officer
Mukesh Kumar Mandal, Geologist Joy.S, Geologist	Signature of the senior most author
Name of Supervisory Officer	Date of receipt of report
Shri, Subhash Yaday	
Superintending Geologist	Date of completion of scrutiny
Sapermenting Geologist	Date of handing over report to the author after scrutiny
132/65	Signature
Name of author(s)	Date of receipt after scrutiny 05.1.07/16
To whom the report has been handed over by	Signature
the Supervisory Officer	Date of resubmission 24/10/2016
Mukesh Kumar Mandal, Geologist	
Joy.S, Geologist	Signature.
Name of Supervisory Officer	Date of receipt of report
Shri, Subhash Yaday	Date of completion of scrutiny
Superintending Geologist	71 10 2016
	Date of handing over report to the author after scrutiny
	3 June
	Signature 37/1911
Name of author(s)	Date of receipt after scrutiny3.1./10/2016
To whom the report has been handed over by	
the Supervisory Officer	Date of resubmission
Mukash Kuman Mandal Caalagist	Signatura
Mukesh Kumar Mandal, Geologist Joy.S, Geologist	Signature
Name Supervisory Officer:	Date of receipt after modification 25.11.2016.
	Date of handing over report to the Regional Mission
	Head 25:11.16
6	SignatureBury
Name of Regional Mission Head	Date of receipt of report 2, 5711/16.
Dr. L. S. Shekhawat, Dy. D. G & RMH-II	Date of handing over the report after peer review to the
DI. L. S. SHCKHAWAI, Dy. D. G & RWIH-II	Project Director
	Signature Stoup 1

Name Supervisory Officer:	Date of receipt of report3.0:
Name of author(s) Mukesh Kumar Mandal, Geologist Joy.S, Geologist	Date of receipt of report from Supervisory Officer 30.11.2016 Date of handing over report after modification to Supervisory Officer. 30.11.2016
	Signature
Supervisory Officer:	Date of handing over report to the Regional Mission Head
Name of Regional Mission Head Dr. L. S. Shekhawat, Dy. D. G & RMH-II	Date of receipt of report after modification from Supervisory Officer32:11: 6 Date of handing over report to the HOD of the region for approval34:11:
7 2 6	Signature Says
Shi RS, Garkhal Dy. D. Cr.	Date of receipt of report for approval Date of approval
	Director3.6
Name of the Project Director	Date of receipt of report after approval of HoD30 \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\



Geological Survey of India

Certificate of Quality of the report

Project/Division: Fertilizer Minerals (FM)

FSP No. Item no. 56, ME/WR/RAJ/2015/049 M

Mission: II-A

Title of the report: Preliminary search of potash in glauconitic sandstone/shale of Vindhyan Supergroup exposed in the parts of Sawai Madhopur and Karauli districts, Rajasthan.

Part-A

This is to certify that the following officer(s) have carried out the above mentioned FSP, and are responsible for collection of field data, carrying out the required laboratory analysis, compilation and synthesis of field data, coalition of the data and writing of the report as per the approved guidelines. The duration of field stay of each officer(s) is as against his/her name.

Name(s)/Designation of the Field	Total field stay during the	e Signature with date
Officer	FSP (no. of days)	20 10 11
	FSP 2015-16	
Mukesh Kumar Mandal, Geologist	144 days	menerals]
Joy.S., Geologist	55 days	Ang lu

Part-B

This is to certify that drilling has been carried out and completed as per the table given below: N.A

Drilling Unit No	Date of commencement of drilling	Date of completion of drilling	Name and Signature of the Director Drilling
1. Out sourced to M/s Super Engineering works, (P) Limited	22.02.2016	08.05.2016	NA

Part-C

This is to certify that geophysical component of the item has been carried out as per the table given below: **N.A**

Name(s)/Designation of Geophysist	Date of commencement of work	Date of completion of work	Signature with date of the Geophysist
1.	N.A		
2.	-		
Name and sign	ature with date of the Direc	ctor (Geophysics)	

Part-D

This is to certify that the chemical analysis of the geological samples has been carried out as per the table given below:

Name of Director in charge of the Chemical Lab		Dates of of sampl the field officer/p	es from		Date of providing complete analytical results to the field officer	Signature with date of the Director Chemistry
sue 8		P.R. No.	Submission Date	No of samples		
star		X-3673	21/07/15	06	05/09/15	
5%		X-3733	30/10/15	23	11/01/2015	
5. 8		X-3748	13/11/15	05	11/01/2015	
		X-3780	30/11/15	08	09/01/2016	
. 0	B	X-3848	28/12/15	18	05/05/2016	
Q.A.	R	X-3863	04/01/16	02	07/01/2016	1 ob ()
1.0	S	X-3926	01/02/16	109	06/06/2016	1) At 1 m
		X-4030	08/03/16	48	20/06/2016	The sun
		X-4102	30/03/16	02	13/06/2016	प्रकाश संभागि।
	1	X-4150	02/05/16	100	18/10/16	चम प्रकाश सेना
		X-4169	19/05/16	82	18/10/16	I Shama
/	C	X-4151	02/05/16	208	18/10/16	इव प्रभारी
//	S	X-4170	19/05/16	47	31/08/16	DIRECTOR OF THE PROPERTY OF TH

Part-E

This is to certify that the below mentioned Supervisory Officer(s) have supervised the above item and have provided guidance to the Field Officer(s). The number of inspection visits and total duration of field visits is as per the below table. It is also certified that the work carried out under the project is of high standards, the norms of field work, lab work etc. have been followed. It is also certified that thorough scrutiny of the report for maintaining the scientific contents and its Quality has been overseen.

Name(s)/Designation Of the Supervisory Officer	No. of inspection visits made to the field area	Total no. of days spent on inspection visit	Signature with date
Shri. Subhash Yadav,	FSP: 2015-16	FSP: 2015-16	31/17/14
Superintending Geologist	04 visits	12 days	

Part-F

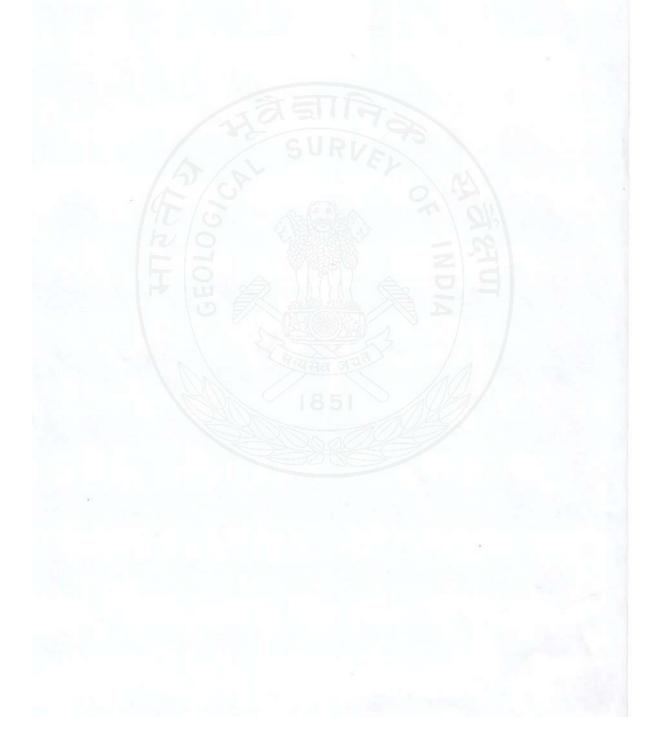
This is to certify that the report has been thoroughly scrutinized at the Regional Mission Head level. The scientific contents and the Quality of the report are certified. The report has been peer reviewed and the needful corrections have been attended to.

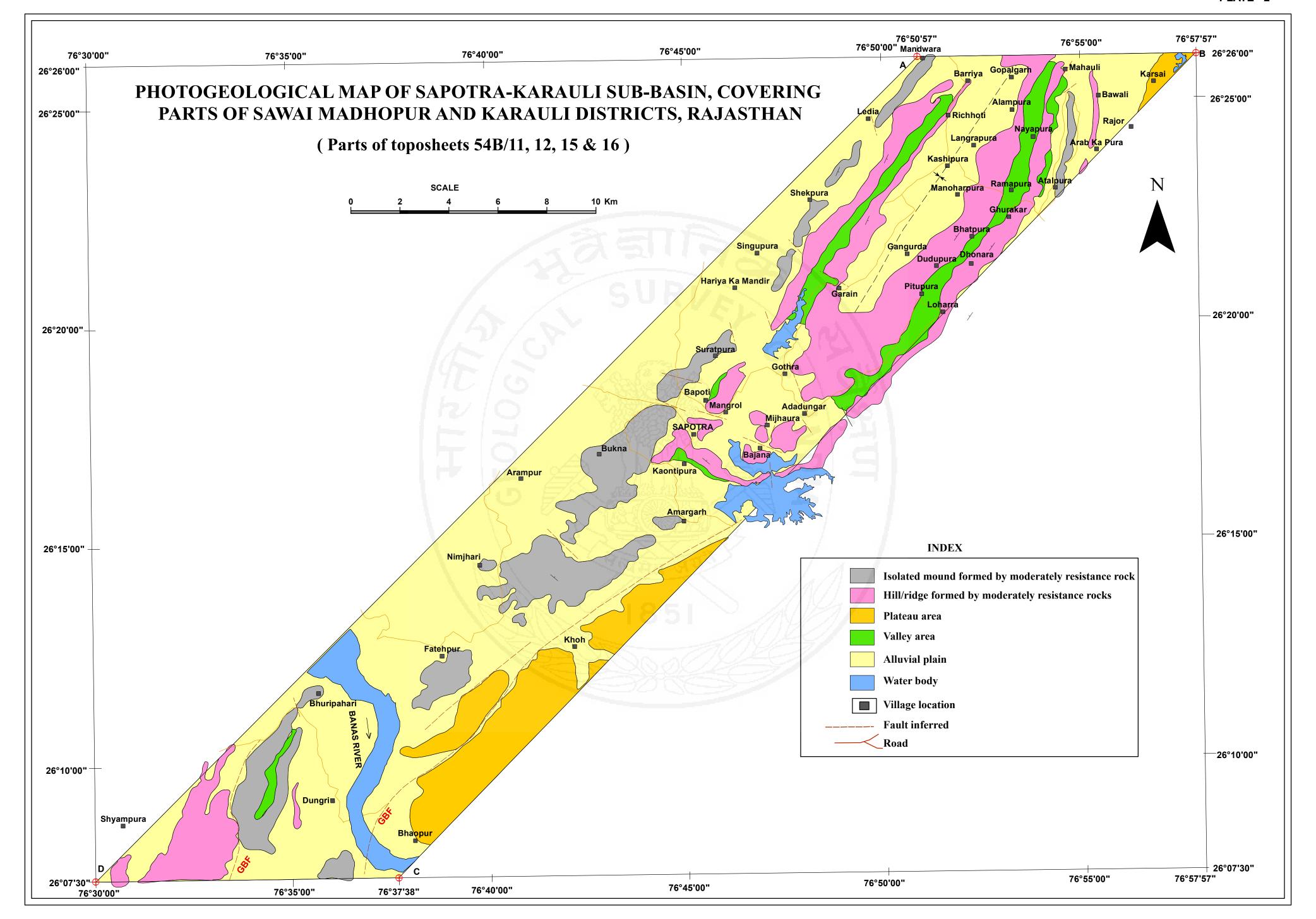
Signature with date
Land 30 miles


Part-G


This is to certify that the above report has been scrutinized at various levels and has also been peer reviewed. On being satisfied regarding the scientific contents and the Quality of the report, the undersigned has accorded approval for its circulation.

Name(s)/Designation of the	Signature with date	
Regional HoD	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	
Shri R.S. Garkhal	diffile	
Dy. D. G.	301.	

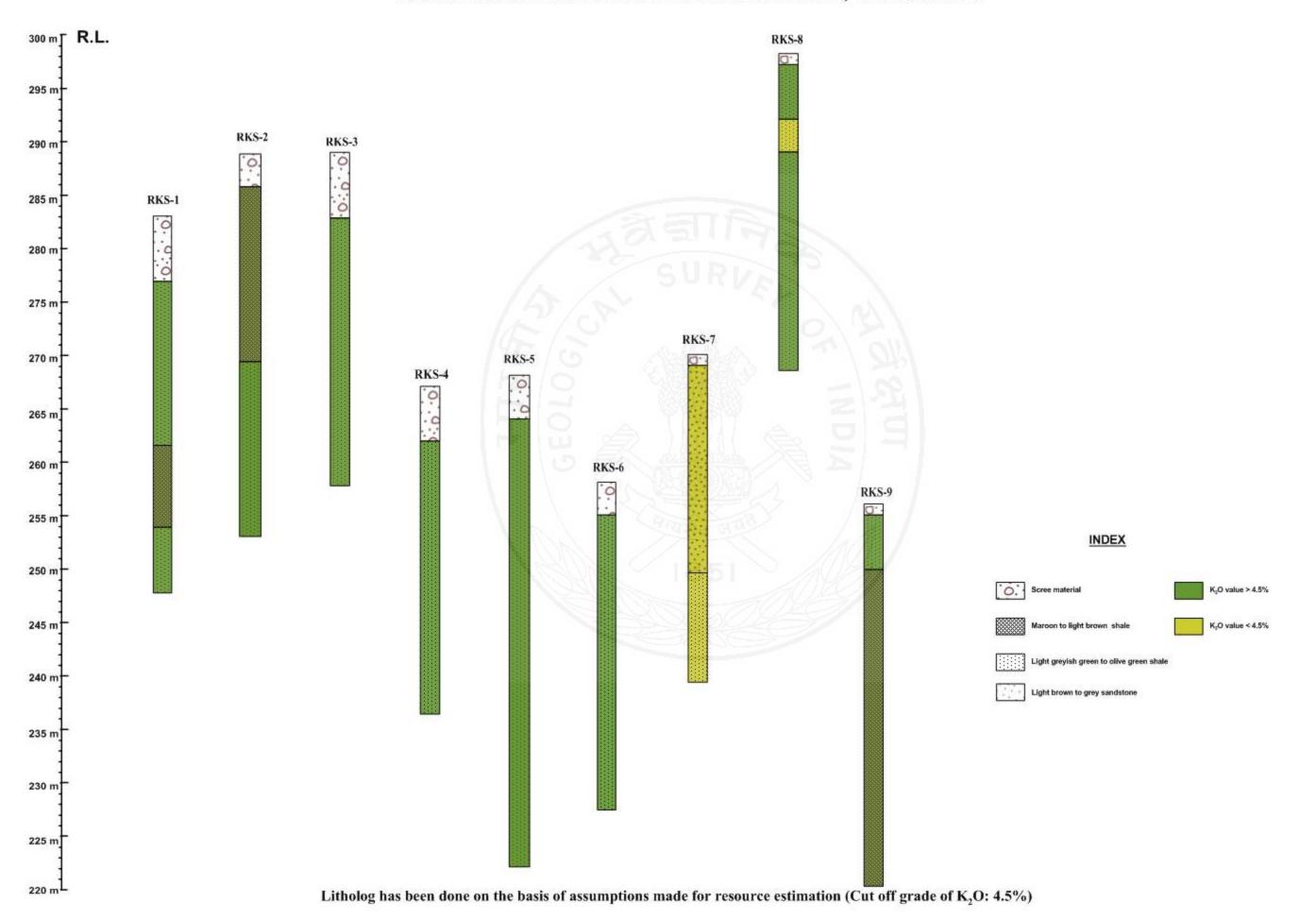




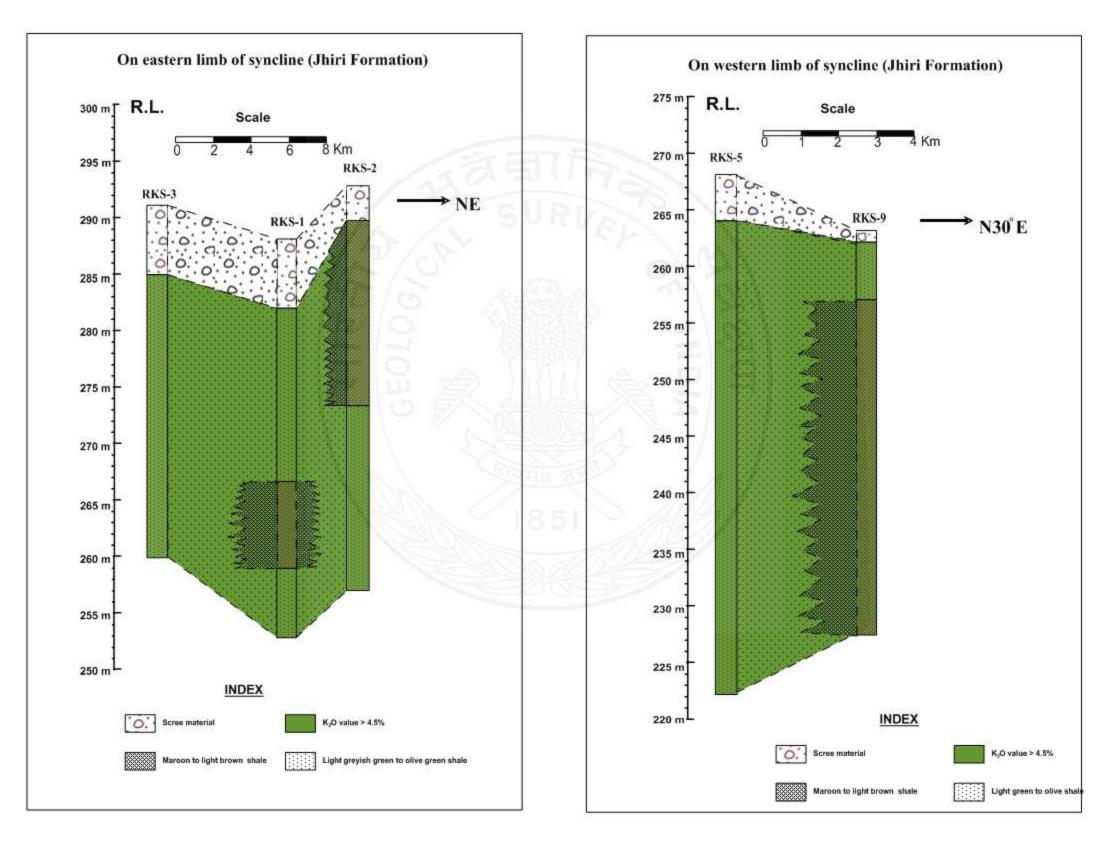




LITHOLOG OF SCOUT BOREHOLES RKS-1 TO RKS-9 DRILLED IN SAPOTRA- KARAULI SUB BASIN, SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN.



CORRELATION OF ZONES IN BORE HOLES RKS-1, RKS-2, RKS-3 AND RKS-5, RKS-9 DRILLED IN SAPOTRA- KARAULI SUB BASIN, SAWAI MADHOPUR AND KARAULI DISTRICTS, RAJASTHAN.



Correlation of zones has been done on the basis of assumptions made for resource estimation (Cut off grade of K2O: 4.5%)

राजस्थान सरकार

Government of Rajasthan

निदेशालय, खान एवं भू-विज्ञान विभाग

DIRECTORATE OF MINES & GEOLOGY

खनिज भवन / Khanij Bhawan, उदयपुर / Udaipur, [313001] दुरभाष / Phones : 2415091-95, फेक्स / Fax : 0294-2410526

E-mail: adghq.mg@rajasthan.gov.in

No. DMG/Geol/SFA/ NPEA/341K/2021-22/

To,

Director

GeoExpOre Pvt Ltd.,

Koramangala, Bengaluru -560095

Sub: Request for In-principal Approval for exploration through NMET fund

Ref: Your office letter no. GEO/NMET/RAJ/04(R)/2023-24 and GEO/NMET/RAJ/07(R)/2023-24 dated 29.01.2024

Sir,

In connection with above cited subject, GeoExpOre Pvt Ltd. has sought in-principal Approval for preliminary exploration (G3 Stage) for Cement Grade Limestone and Associated Minerals around Baramsar & Jethwai villages, Dist: Jaisalmer (18.10 Sq.Km.) and Preliminary Exploration (G3 Stage) for Potash in Glauconitic Sandstone and Associated Minerals around Baniya Khora, Pitupura and Dudupura Villages District Karauli (9.70 Sq.Km.) vide referred letters. As per information received from concerned office, both the proposed blocks are free from any litigation, held mineral concessions and definition of Aravalli hills. Therefore, both blocks may be proposed for further exploration. Submitted for information and further necessary action.

Enclosed: As above

Yours faithfully

(H.C. Songara)
Additional Director Geology (HQ)

Copy to: Director, Ministry of Mines, Govt. of India, Shastri Bhawan, New Delhi for information.

Signature valid

RajKAdditional Director Geologian

5771173

Digitally signed by Her Chand

Songara

Designation Additional Director

Date: 2024.02.22 8:14:01 IST

Reason: Approved