भारत सरकार
GOVERNMENT OF INDIA
खान मंत्रालय
MINISTRY OF MINES
शैललकी प्रभाग / Petrology Division
भारतीय भूवैज्ञालनक सवेक्षण / Geological Survey of India
दलक्षण क्षेत्र / Southern Region
बैंडलागुडा / Bandlaguda
हैदराबाद / Hyderabad-500068

No. 2611/TCS/GSI/Pet/EPMA/SR/2025 Date: 26/11/2025

Petrographic report

.

Sender details

K. Nageswar Rao, Director (G), PR & Corordination,
Critical mineralTrackers,
Hyderabad

Madam,

Please find the attached petrographic report on submitted samples (22 nos.) for your perusal.

Thanking you,

Yours sincere

K. Basak

(Dr. KRISHNAPRIYA BASAK)

कृष्णप्रिया बसाक / KRISHNAPRIYA BASAK
निदेशक / Director
क्षेत्रीय मुख्यालय / Regional Headquareter
भारतीय भूवैज्ञानिक सर्वेक्षण / Geological Survey of India
दक्षिणी क्षेत्र, हैदराबाद / Southern Region, Hyderabad-500 068

1. Sample code: LB/TS/B5

Microscopic observations:

Microscopic study reveals that the rock displays a very fine-grained groundmass, typical of shale, with particle sizes mostly below 100 micrometers. The grains are closely packed in a matrix-supported texture, and little sorting is observed, consistent with rapid settling from suspension in a quiet water setting. The preferred orientation of fine grains creates a fissile fabric, giving the rock its characteristic ability to split into thin layers. Some larger quartz grains are embedded within this matrix, further demonstrating the heterogeneity at the microscale (Fig. 7A-7D).

Quartz (Qz) grains are clearly identifiable across all images, scattered throughout the clay-rich matrix. Quartz occurs as both fine angular fragments and larger, subrounded grains, indicating a mix of detrital influx from distant and nearby sources. The prevalence of quartz highlights the siliciclastic nature of this shale and suggests significant mechanical weathering and transport before deposition.

No obvious secondary mineralization or cementation phases such as carbonates or silica overgrowths are visible, suggesting minimal post-depositional alteration. The fine clay matrix, likely dominated by illite, kaolinite, or smectite, binds the framework and contributes to the rock's compact nature. The lacking signs of recrystallization or strong compaction indicate a relatively low diagenetic maturity.

Overall, the shale is a fine-grained, quartz-rich sedimentary rock with a prominent clay matrix. The mineral assemblage and fissile texture point to deposition in a calm, low-energy environment. The dominance of quartz and lack of abundant authigenic minerals or cement suggest primary mud deposition without significant diagenetic alteration. These features are diagnostic for shales formed from suspended clay and silt settling in relatively undisturbed aquatic settings.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a Shale.

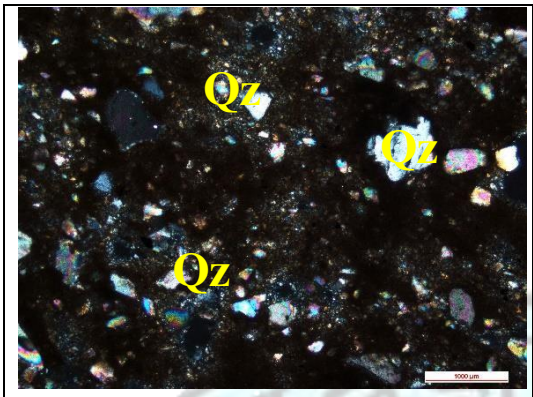

Fig. 1A. Photomicrograph showing presence of different grain size of quartz(Qz) in clay matrix under transmitted light XPL (5X).

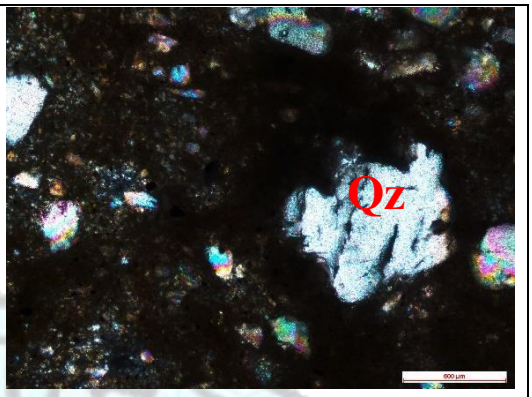

Fig. 1B. Photomicrograph showing presence of different grain size of quartz(Qz) in clay matrix under transmitted light XPL (10X).

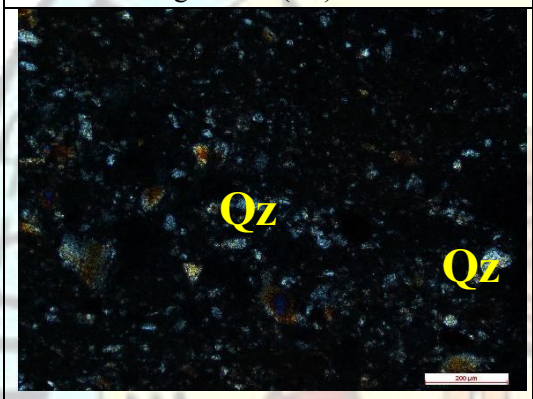

Fig. 1C. Photomicrograph showing presence of different grain size of quartz(Qz) in clay matrix under transmitted light XPL (2X).

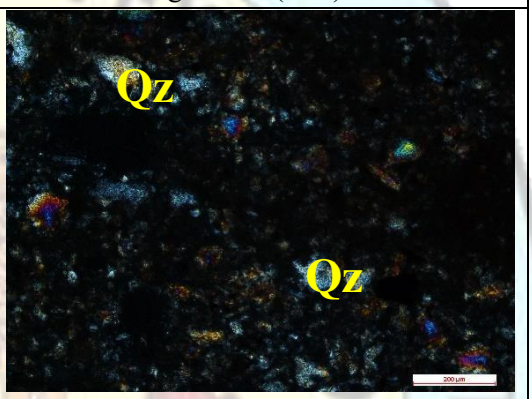

Fig. 1D. Photomicrograph showing presence of different grain size of quartz(Qz) in clay matrix under transmitted light XPL (2X).

2. Sample code: LB/TS/BRS-1

Microscopic observations:

Microscopic study reveals that the rock shows iron oxides are by far the most abundant and pervasive minerals, as evidenced by their consistent reddish-brown appearance and extensive distribution throughout the rock. The iron oxide phases, primarily goethite and hematite, dominate the groundmass with a fine-grained, almost cryptocrystalline texture. The presence of goethite (Gth) manifesting as concentric yellow-brown zones—typical for its nodular habit in laterite (Fig. 8A-8D). Quartz (Qz) grains occur sporadically and are subordinate to the iron oxides, suggesting minor preservation of primary minerals from the parent rock.

The overall matrix is extremely fine-grained, poorly sorted, and appears primarily structureless except for occasional relict quartz or goethite nodules. Quartz grains are subangular and dispersed within the iron oxide matrix. Goethite nodules present as concentric growths, sometimes around remnant quartz or other detrital grains, indicating strong replacement and secondary precipitation processes during lateritization. The dominance of the iron oxide matrix over preserved silicate minerals illustrates the intense chemical weathering that characterizes laterite formation.

The dominance of iron oxides, with only minor quartz and the presence of goethite nodules, is indicative of advanced lateritization—a process involving prolonged tropical or subtropical weathering, where leaching removes silica, alkalis, and other bases. The concentric goethite structures around relict grains highlight multiple generations of iron precipitation and secondary nodular growths, a symbol of mature laterites. Minimal cementation and open matrix texture have resulted in moderate porosity, which may facilitate further weathering and occasional secondary mineral infilling under changing soil chemistry conditions.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a Laterite.

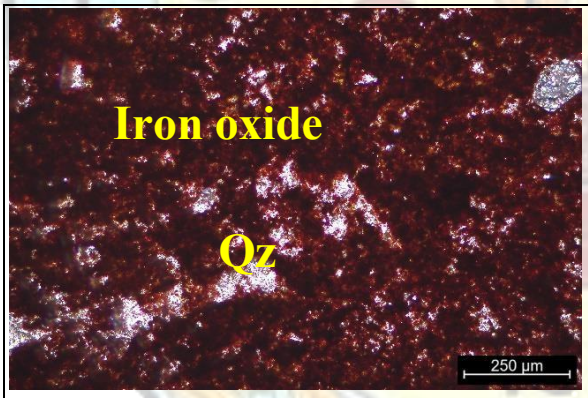

Fig. 2A. Photomicrograph showing presence of iron oxide and quartz (Qz) under transmitted light XPL (10X).

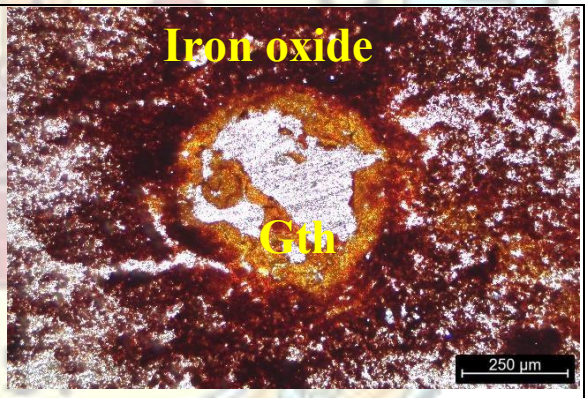

Fig. 2B. Photomicrograph showing presence of iron oxide and Goethite (Gth) under transmitted light XPL (10X).

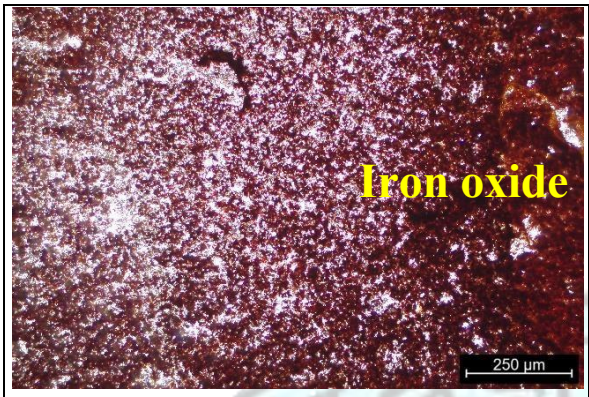

Fig. 2C. Photomicrograph showing presence of iron oxide under transmitted light XPL (10X).

Fig. 2D. Photomicrograph showing presence of iron oxide under transmitted light XPL (10X).

3. Sample code: LB/TS/P17

Microscopic observations:

Microscopic study reveals that the rock displays iron oxides are the predominant mineral phases, distributed pervasively throughout rock. Specifically, quartz (Qz) is consistently present, but always as a subordinate phase. Hematite (Hem), identifiable by its deep red coloration and granular to earthy textures, appears in distinct masses and aggregates, typical of advanced ferrugination in mature laterites. Goethite is not specifically labeled in this image, but iron oxide distribution may include finely dispersed goethite in the matrix (Fig. 9A-9D).

Quartz grains, when present, are embedded within this iron-rich groundmass and display angular to subangular forms. Hematite occurs as large, locally massive, or variegated patches, suggesting precipitation from iron-rich solutions during or after intense weathering. The microtextures range from earthy, massive areas to discrete crystalline zones, indicating multi-stage iron accumulation and cementation.

The dominance of hematite points to oxidative conditions and mature weathering, while sporadic quartz grains mark relict remnants of parent silicates. No significant evidence of secondary carbonates or clay minerals is present,

Overall, Textural and mineral evidence support formation through prolonged leaching, iron enrichment, and secondary mineral growth in a well-drained, oxidizing environment. These

petrographic features define advanced laterite, typical for soils overlying igneous or metamorphic rocks in tropical regions.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a Laterite.

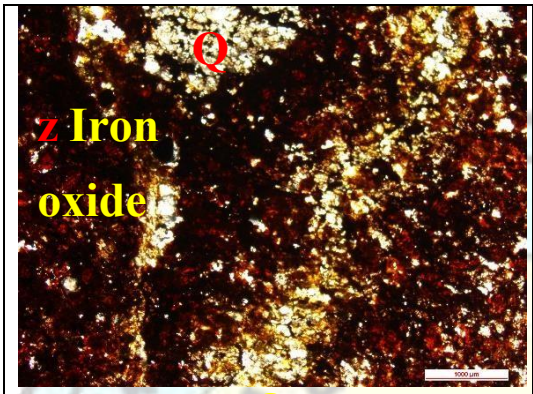

Fig. 3A. Photomicrograph showing presence of iron oxide and quartz (Qz) under transmitted light XPL (5X).

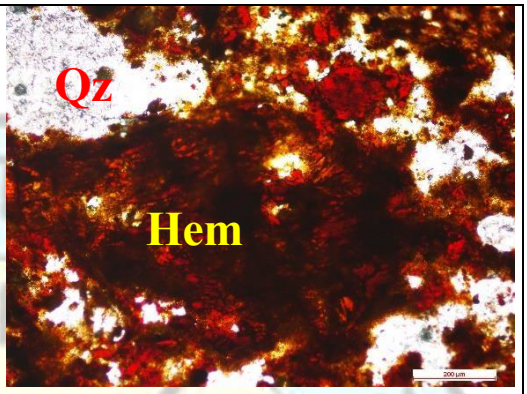

Fig. 3B. Photomicrograph showing presence of Hematite (Hem) and quartz (Qz) under transmitted light XPL (10X).

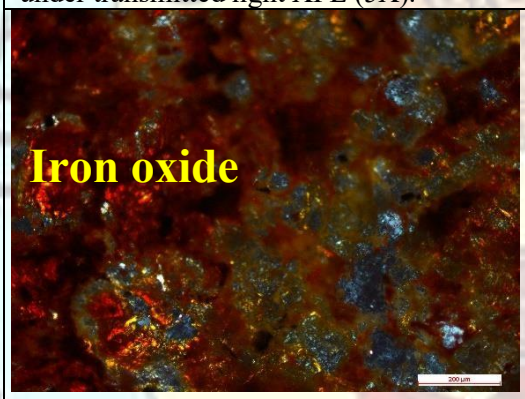

Fig. 3C. Photomicrograph showing presence of iron oxide under transmitted light XPL (10X).

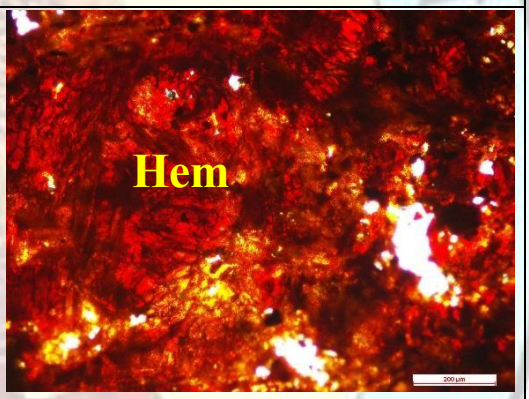

Fig. 3D. Photomicrograph showing presence of Hematite (Hem) under transmitted light XPL (10X).

4. Sample code: LB/TS/T5

Microscopic observations:

Microscopic study reveals that the rock demonstrate a matrix-supported texture, where quartz grains are enveloped by a fine-grained iron oxide matrix. The distribution appears heterogeneous, with clusters of iron oxide and sporadic quartz grains interspersed throughout. The rutile grains are discretely located among the matrix, further emphasizing the advanced state of

chemical alteration. The very fine grain size and poor sorting reflect intense leaching and minimal preservation of primary rock fabric.

Quartz (Qz) is prominently identified, occurring as angular to subrounded grains typically embedded within a finer matrix. Iron oxide, present in large quantities, forms the dominant groundmass and imparts a brownish hue to the entire fabric. Its microcrystalline nature suggests pervasive chemical weathering and mobilization of iron from original host minerals. Notably, rutile (Rt) is observed, marked by its high relief and distinct shape—rutile's presence is significant as it is highly resistant to chemical breakdown, surviving prolonged weathering (Fig. 10A-10B).

The prevalence of iron oxide and rutile, coupled with the sparse occurrence of quartz, indicates an advanced lateritic profile—typical of prolonged tropical or subtropical weathering (Fig. 10C-10D). Leaching has removed most silicates and bases, leading to enrichment of insoluble iron oxides and accessory heavy minerals like rutile. There is no evidence of secondary carbonate or significant clay mineral presence, showing the dominance of ferruginous alteration.

Overall, the rock is characteristic of mature laterite, distinguished by iron oxide-rich groundmass, resistant quartz, and rutile grains. These microstructures and mineral assemblages typify extreme weathering, leaching, and residual enrichment, common in humid tropical climates over felsic or mafic parent rocks. The preservation of rutile and quartz amidst iron oxides further supports the identification of a highly evolved, mineralogically mature lateritic regolith.

Rock/Mineral Name: Based on the mineral and textural characteristics, it is a Laterite.

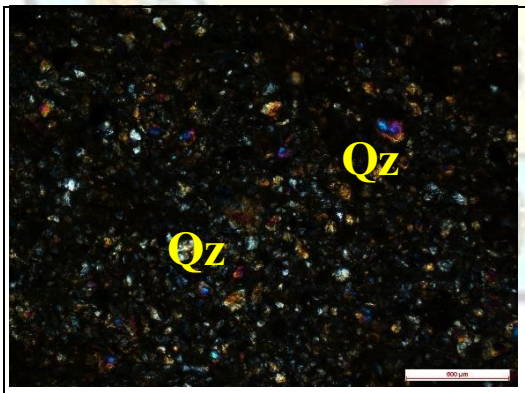

Fig. 4A. Photomicrograph showing presence of quartz (Qz) under transmitted light XPL (2X).

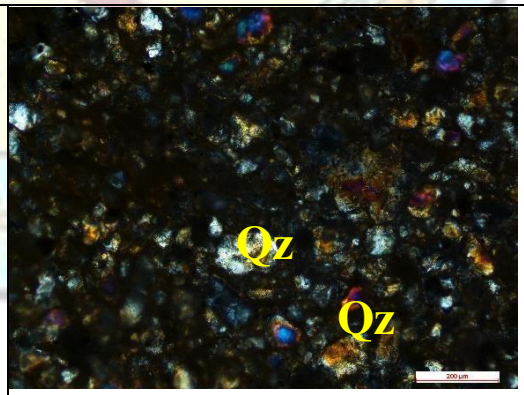

Fig. 4B. Photomicrograph showing presence of quartz (Qz) under transmitted light XPL (5X).

Fig. 4C. Photomicrograph showing presence of quartz (Qz) and Iron oxide under transmitted light XPL (5X).

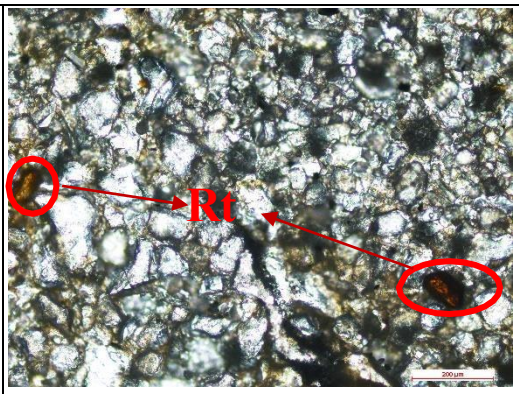

Fig. 4D. Photomicrograph showing presence of quartz (Qz) and Rutile under transmitted light PPL (10X).

5. Sample no.LB/TS/B-8

Mineral assemblage: Framework and matrix mineral: Quartz

Cement: Chert + Iron Oxide

Texture: It is a medium grained clastic sedimentary rock consisting only of quartz as frameworking mineral. Cement is composed of chert and iron oxide binding the frameworking quartz grains. Quartz grains are subangular to sub rounded with secondary authigenic quartz overgrowth. Chert and iron oxide occur as cement binding the frameworking minerals. Authigenic growth of quartz over the earlier detrital grains are noted and a fine rim is discernible on every quartz grains. At places , the rock is cement supported with few clasts of quartz within it. Variable and wide range of grain size of frameworking mineral and angularity of the grains indicate poor sorting and less transportation. Presence of quartz grains only as frameworking mineral indicate second cycle of sedimentation and a sandstone rich provenance.

Name of the rock: Sandstone

Fig. 5.1 Sub-angular to sub-rounded quartz grains as framework minerals; note the quartz overgrowth and ferruginous cement.

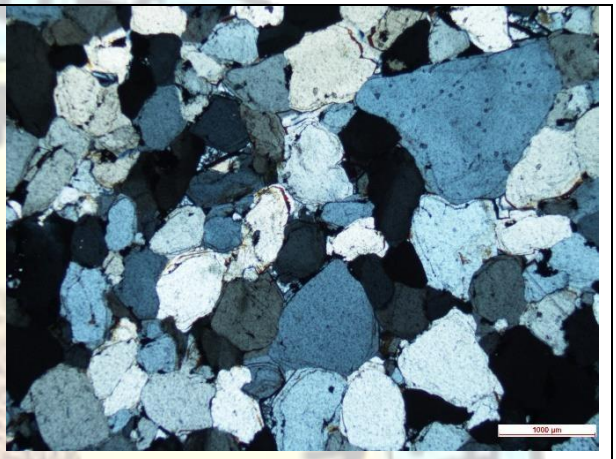

Fig. 5.2 Same as Fig 20.1 under cross polarized light.

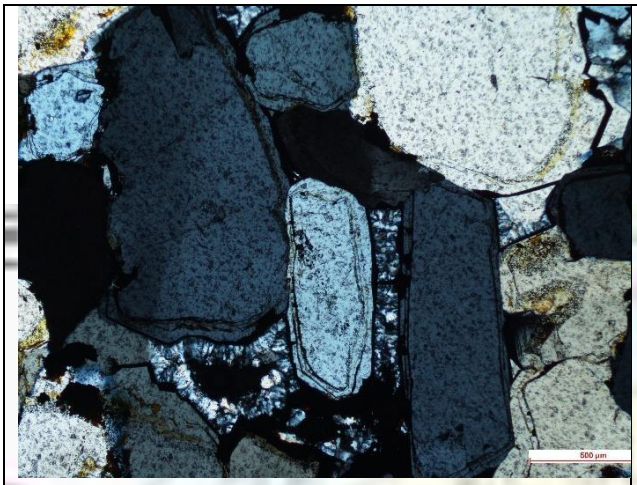

Fig. 5.3 Cherty cement along the grain boundaries; also note the quartz overgrowth

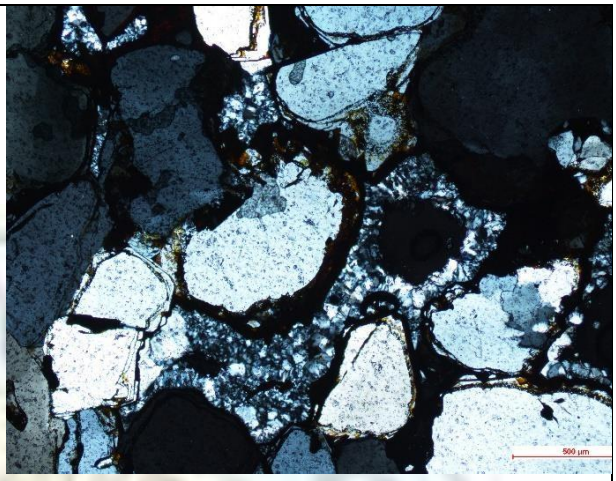

Fig. 5.4 Cherty and ferruginous cement in quartzite

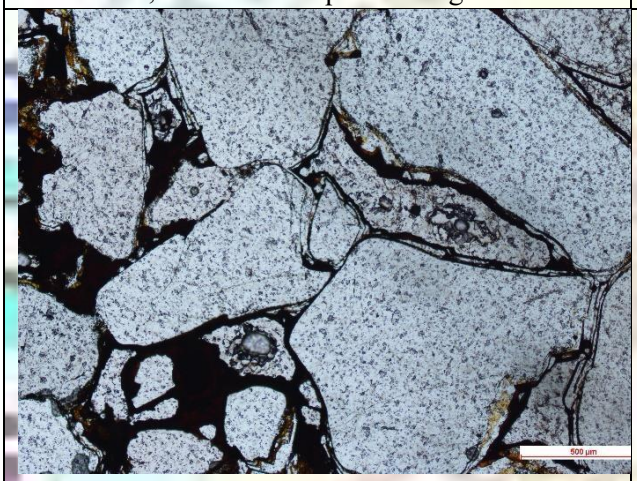

Fig. 5.5 Cherty and ferruginous cement in quartzite; at places ferruginous cement dominated

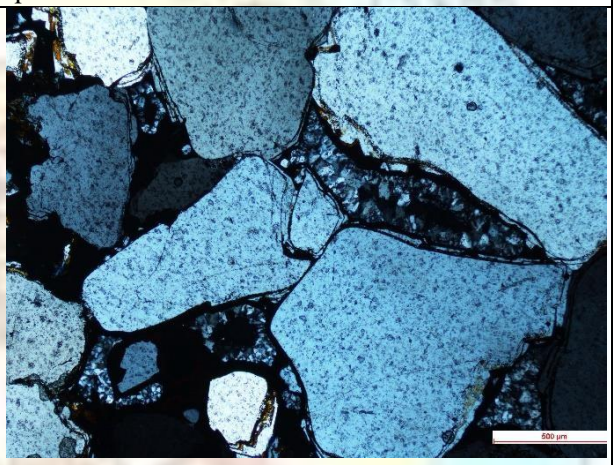

Fig. 5.6 Same as Fig. 20.5; under cross polarized light

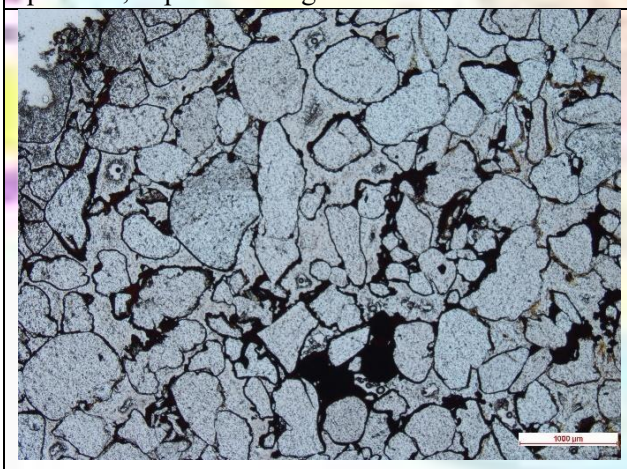

Fig. 5.7 Cherty cement dominated part with rounded and subrounded quartz grains; ferruginous cement also present

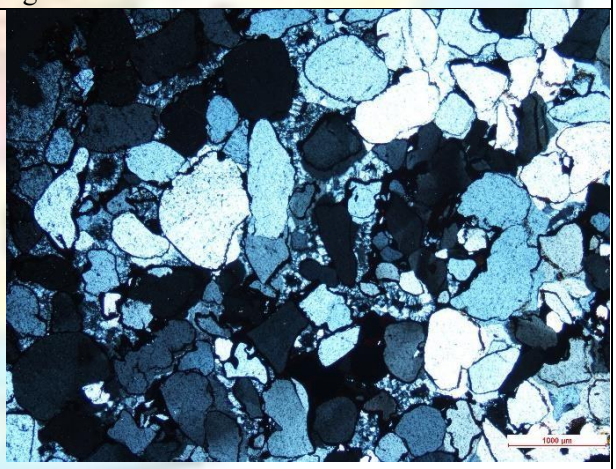

Fig. 5.8 Same as Fig. 20.7 under cross polarized light

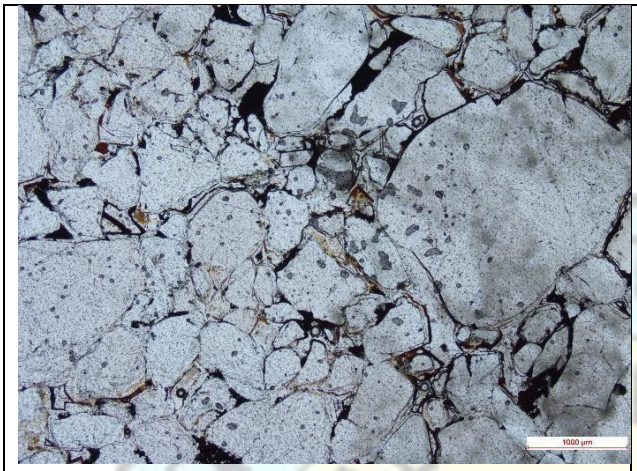

Fig. 5.9 Polymodal grain size distribution; texturally immatured

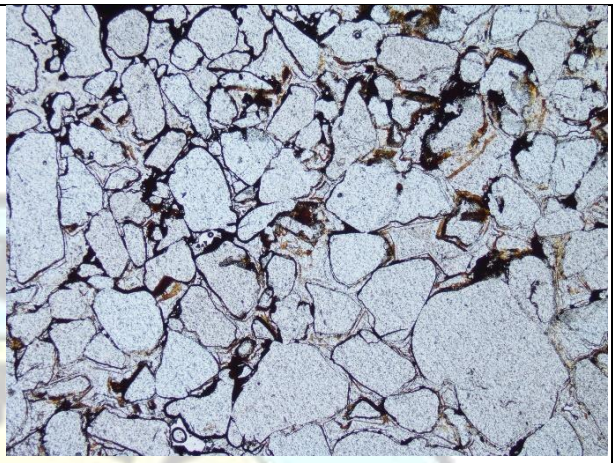

Fig. 5.10 With increasing cement content, frameworking grains often have very little contact increasing the porosity.