

REPORT OF THE LASER RAMAN SPECTROSCOPE STUDIES OF THE SAMPLES MECL, NAGPUR

Samples Submitted by: MECL, NAGPUR

FSP id.

No. of samples submitted: 05 (Five) Nos.

No. of samples studied: 05nos.

Introduction

Laser Raman spectroscopy is a vibrational spectroscopic technique based on inelastic scattering or Raman scattering of monochromatic light, usually from a laser source and is utilized for assessing molecular motion and fingerprinting chemical species of solids, fluids and gases. The basic principle of the technique is illuminating a sample with a laser beam in the ultraviolet (UV), visible (Vis) or near infrared (NIR) range. Photons of the laser light are absorbed by the sample and then reemitted. Frequency of a limited number of reemitted photons are shifted up or down in comparison with original monochromatic frequency, which is called the Raman Effect. This shift provides information about vibrational, rotational and other low frequency transitions in molecules. Raman Scattered light is collected with a lens and the generated Raman spectrum and is analyzed to identify the sample.

Analyzing setup:

- **Laboratory:** Laser Raman spectroscopy, NCEGR, CHQ
- **LASER:** 514 nm edge Ar⁺ laser (gratings: 2400 lines/mm)
- **Spot beam Diameter:** ~ 1.2 μm
- **Focus Energy:** 12 – 15 mW
- **Spectrum Accumulations time:** 20 s.

The room temperature was maintained at $22 \pm 1^\circ\text{C}$. The peak positions of Raman spectra were determined by the Wire program (Version 3.4). The spectral resolution for each Raman vibrational mode is on the order of $\pm 1\text{-}2\text{ cm}^{-1}$.

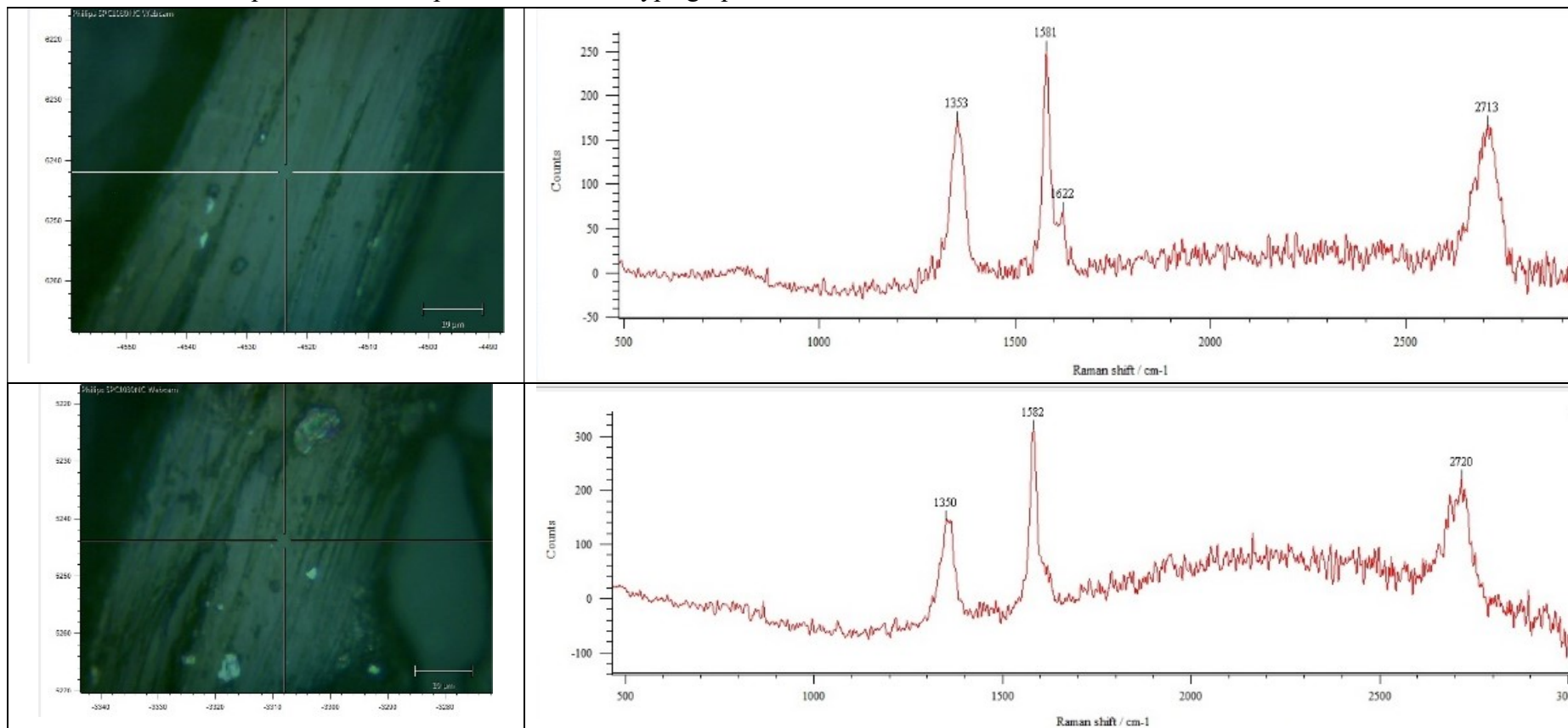
Laser Raman spectroscopy studies of samples 1, 2, 3, 4 and 5

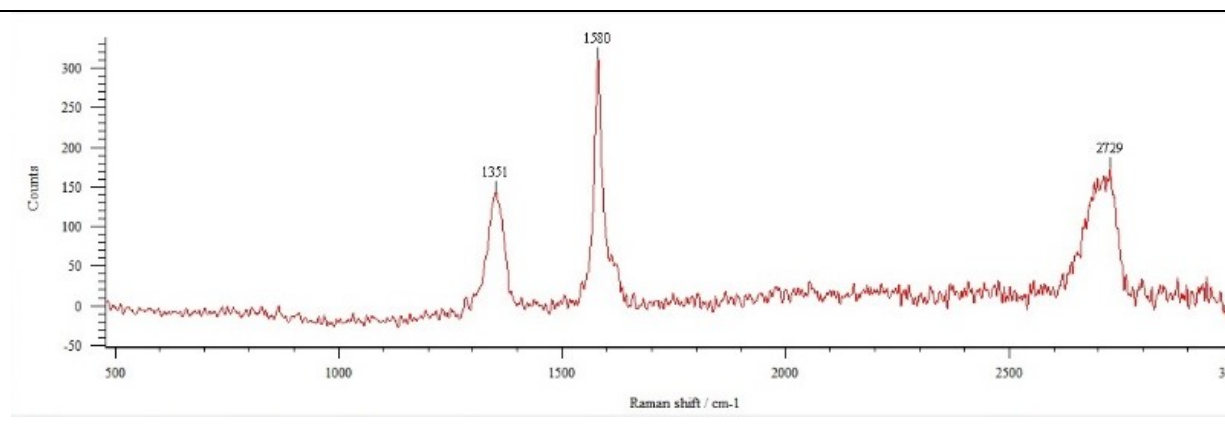
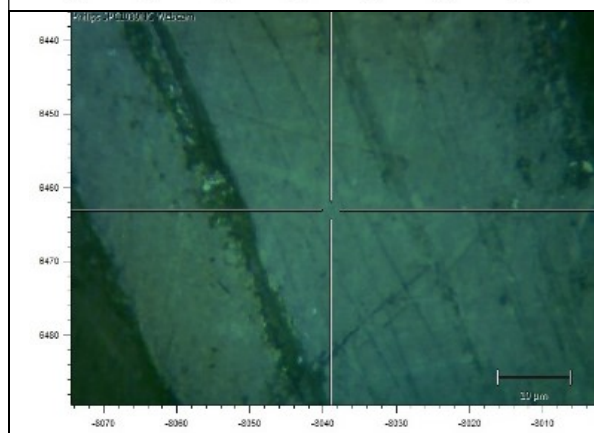
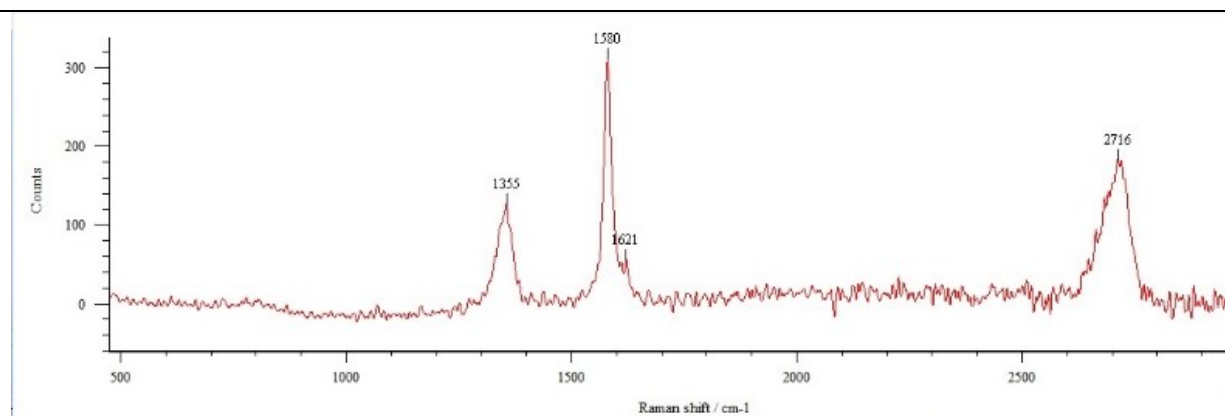
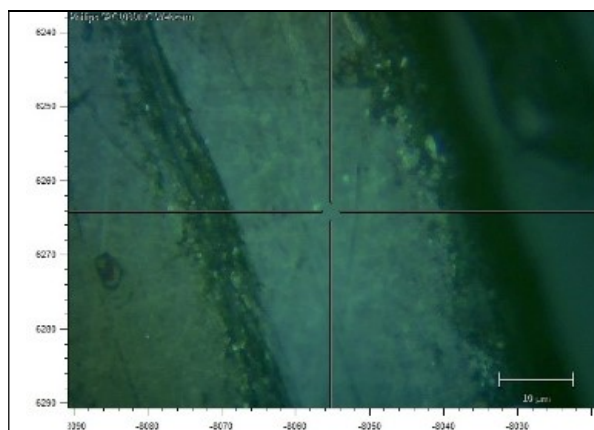
- **Sample No. 1:** The sharp peak at 1580 cm^{-1} , 1581 cm^{-1} , or 1582 cm^{-1} , with shoulder peaks at 1621 cm^{-1} , or 1622 cm^{-1} , along with the smaller peaks at 1350 cm^{-1} , 1351 cm^{-1} , 1353 cm^{-1} , 1354 cm^{-1} , or 1355 cm^{-1} , and second-order peaks at 2713 cm^{-1} , 2716 cm^{-1} , 2720 cm^{-1} , and 2729 cm^{-1} , represent **graphite**.
- **Sample 2:** The peak at 1580 cm^{-1} or 1581 cm^{-1} , with shoulder peaks at 1618 cm^{-1} , 1623 cm^{-1} , or 1624 cm^{-1} along with smaller peaks at 1350 cm^{-1} , 1352 cm^{-1} , or 1354 cm^{-1} , and second-order peaks at 2714 cm^{-1} , 2718 cm^{-1} , 2720 cm^{-1} or 2725 cm^{-1} , represent **graphite**.

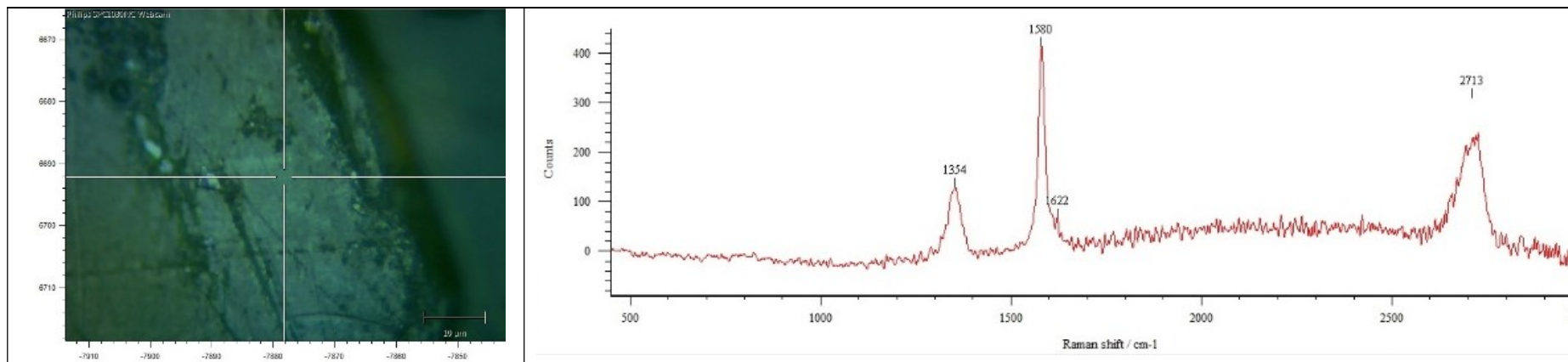
- Sample **3** : The peak at 1580 cm^{-1} , or 1581 cm^{-1} with shoulder peaks at 1620 cm^{-1} , 1622 cm^{-1} or 1623 cm^{-1} , along with smaller peaks at 1348 cm^{-1} , 1349 cm^{-1} , 1350 cm^{-1} , or 1352 cm^{-1} , and second-order peaks at 2711 cm^{-1} , 2716 cm^{-1} , 2726 cm^{-1} , or 2728 cm^{-1} , represent **graphite**.
- Sample **4** : The peak at 1581 cm^{-1} , with shoulder peaks at 1620 cm^{-1} , or 1622 cm^{-1} along with smaller peaks at 1352 cm^{-1} , 1354 cm^{-1} , or 1358 cm^{-1} , and second-order peaks at 2712 cm^{-1} , 2718 cm^{-1} , 2729 cm^{-1} , or 2731 cm^{-1} , represent **graphite**.
- Sample **5** : The peak at 1580 cm^{-1} , or 1581 cm^{-1} with shoulder peaks at 1618 cm^{-1} , 1620 cm^{-1} , 1621 cm^{-1} , 1623 cm^{-1} , or 1625 cm^{-1} , along with smaller peaks at 1349 cm^{-1} , 1354 cm^{-1} , 1355 cm^{-1} , or 1357 cm^{-1} , and second-order peaks at 2714 cm^{-1} , 2715 cm^{-1} , 2718 cm^{-1} , 2718 cm^{-1} , or 2728 cm^{-1} , represent **graphite**.

The single LRS peaks at 1580 cm^{-1} , or 1581 cm^{-1} represent the flaky/massive nature of graphite (Neubeck et al., 2020). Peaks at 1580 cm^{-1} , or 1581 cm^{-1} , along with shoulder peaks at 1618 cm^{-1} , 1620 cm^{-1} , 1621 cm^{-1} , 1622 cm^{-1} , 1623 cm^{-1} or 1624 cm^{-1} and smaller peaks at 1348 cm^{-1} , 1349 cm^{-1} , 1350 cm^{-1} , 1351 cm^{-1} , 1353 cm^{-1} , 1354 cm^{-1} , or 1355 cm^{-1} , represent vein-type graphite.

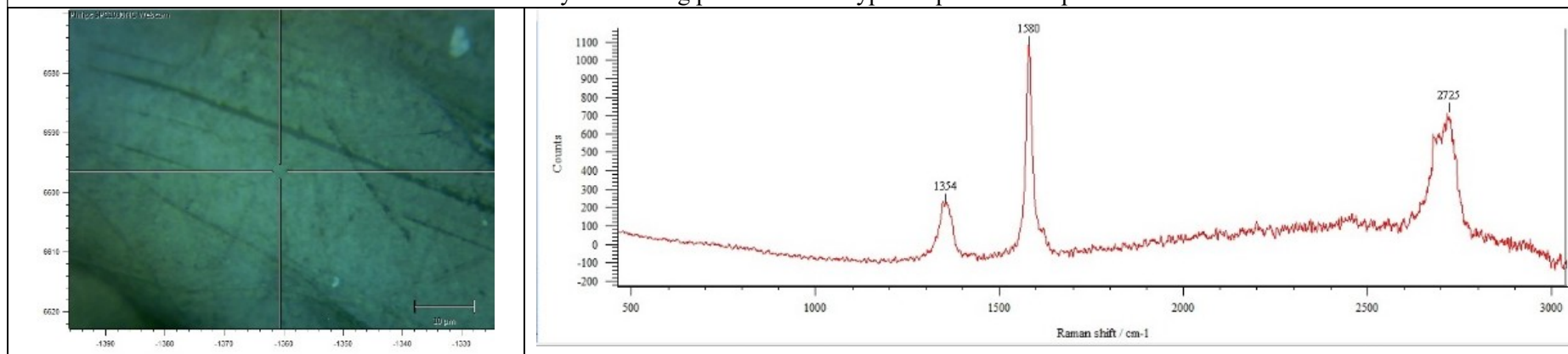
Therefore, the representative samples indicate vein-type graphite.

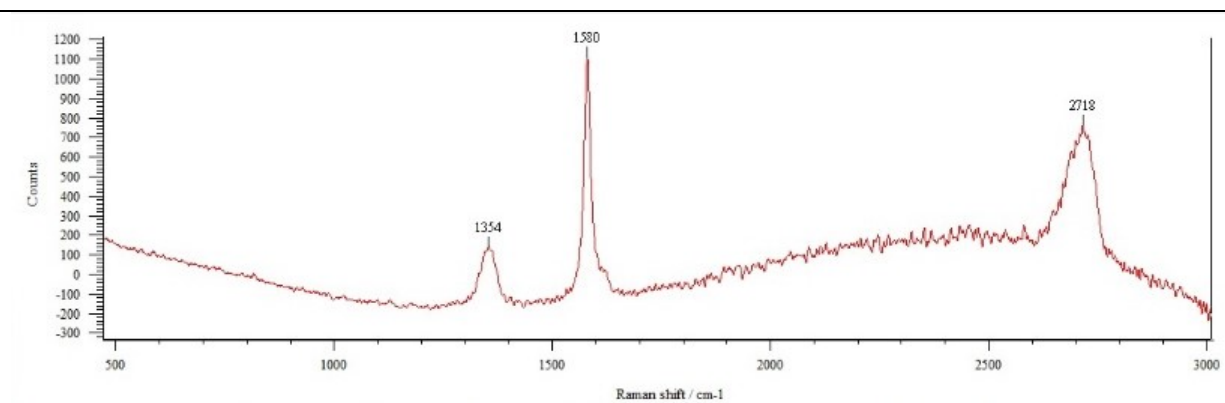
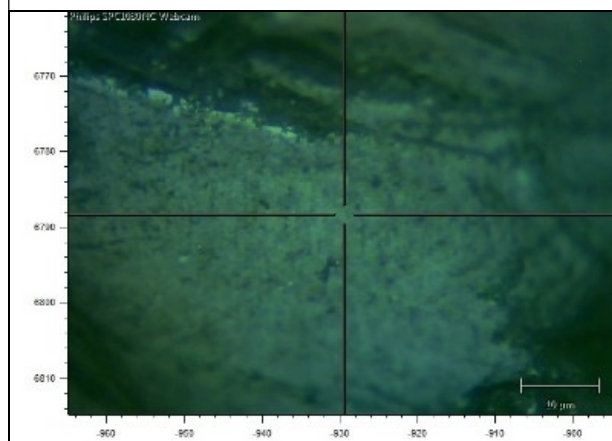
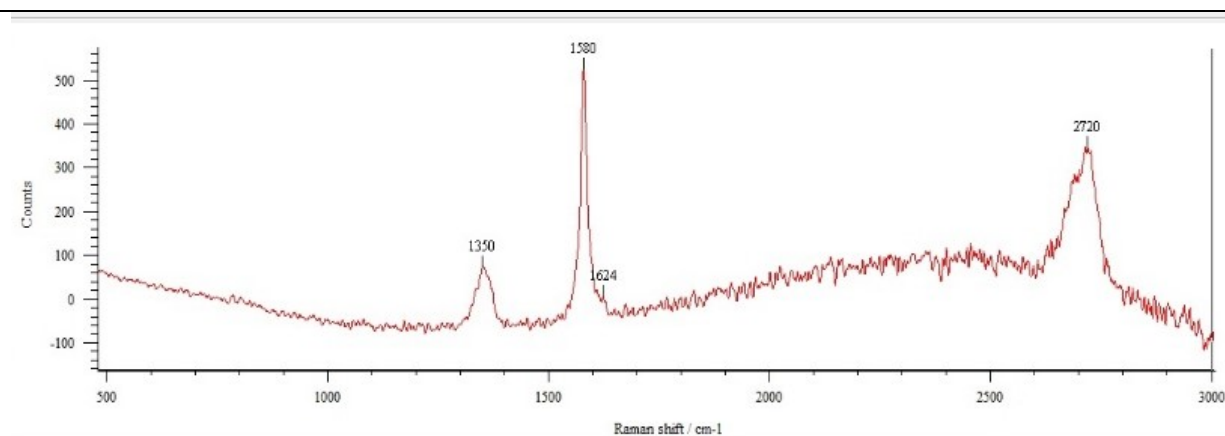
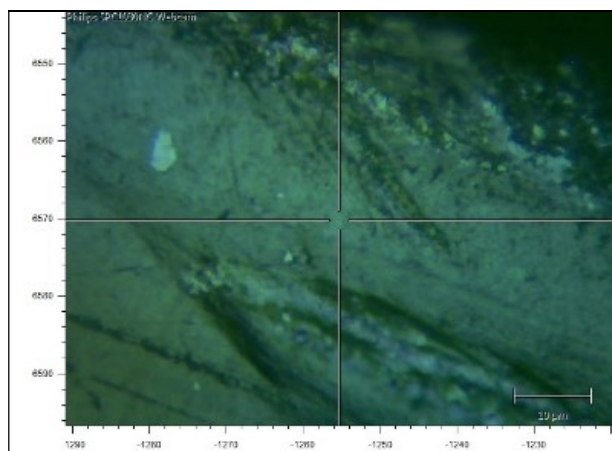


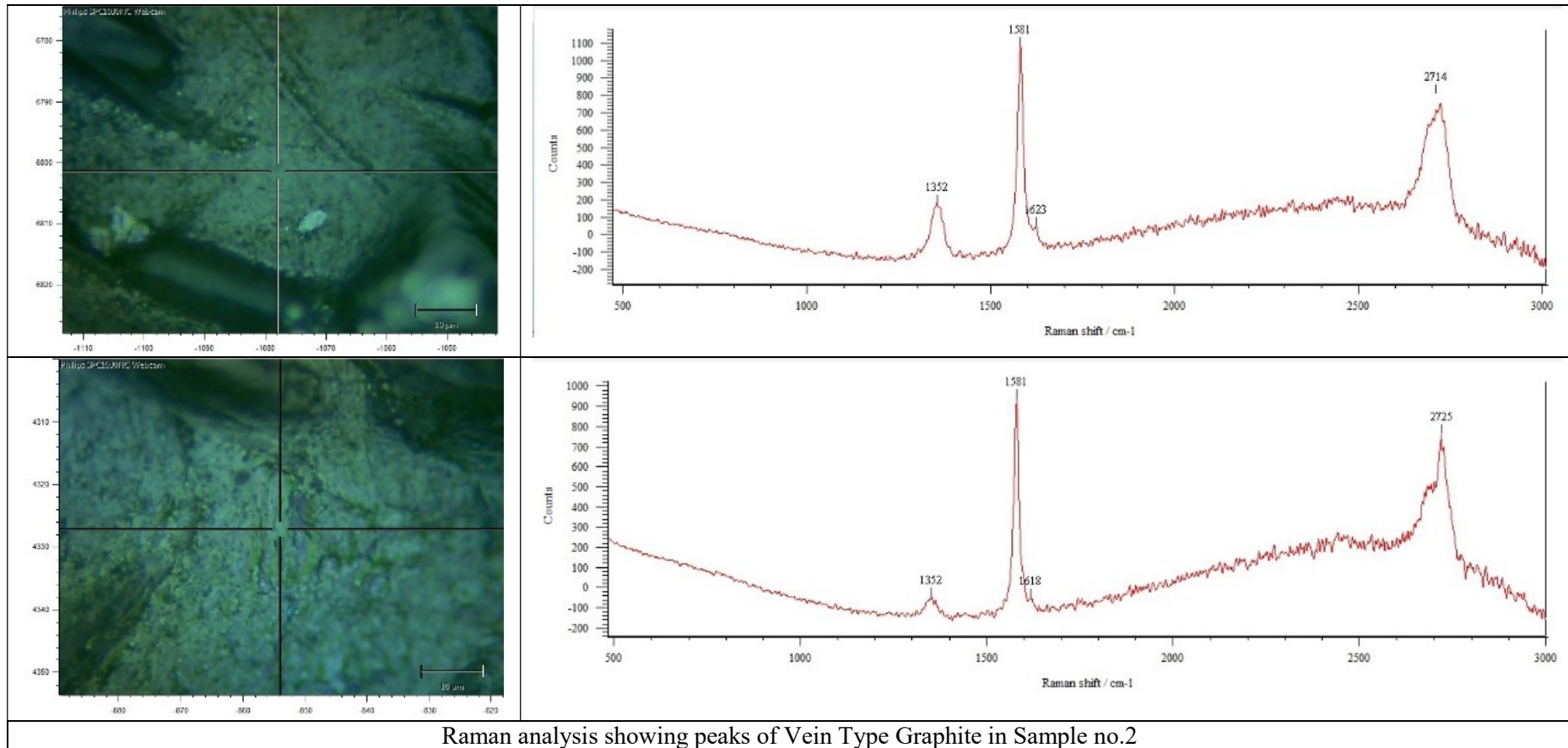


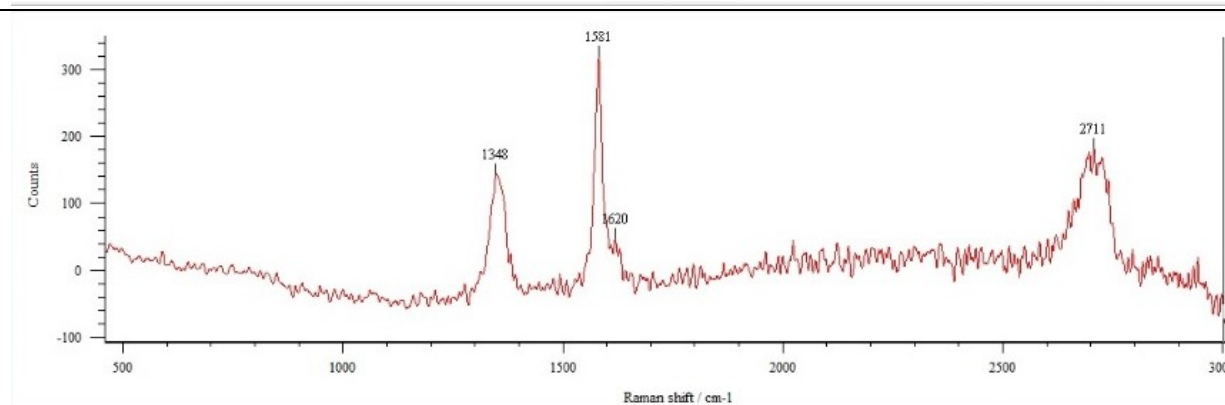
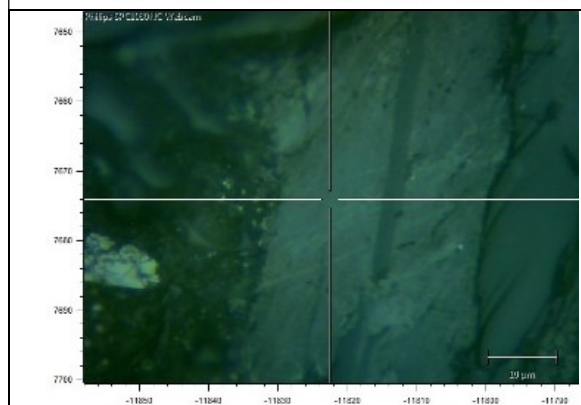
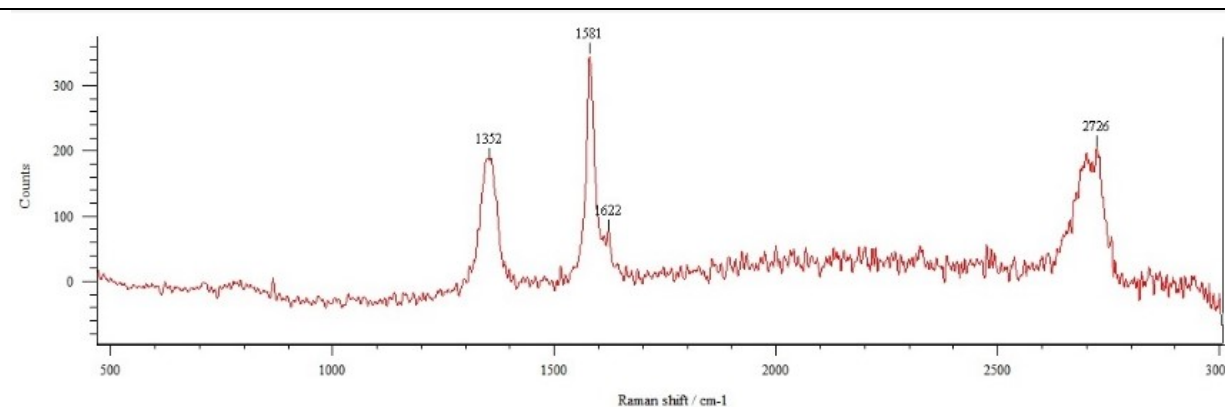
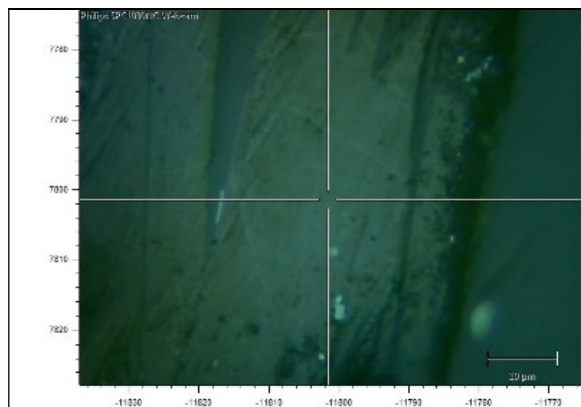


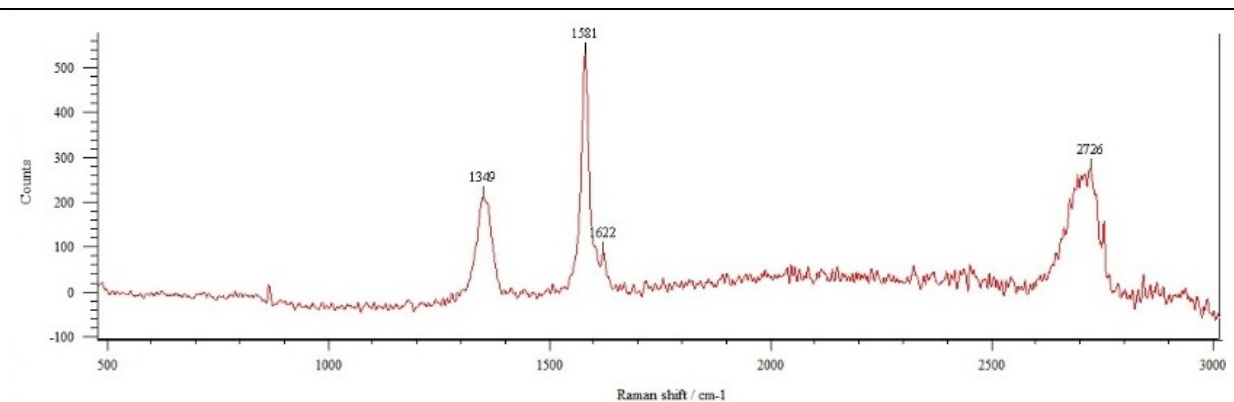
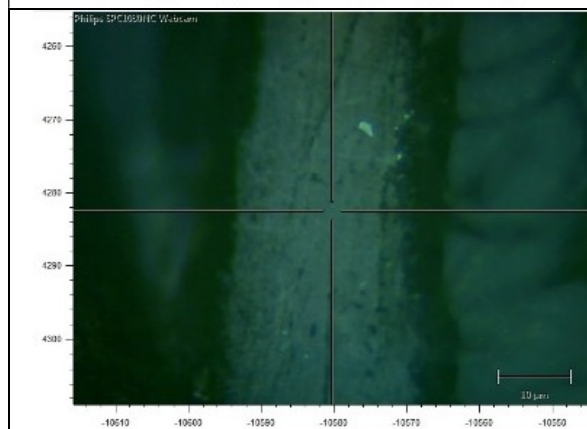
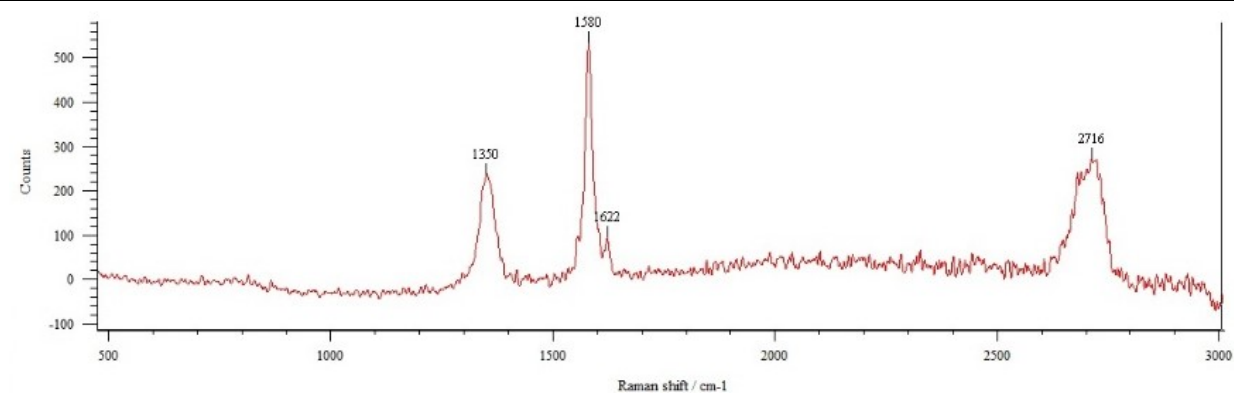
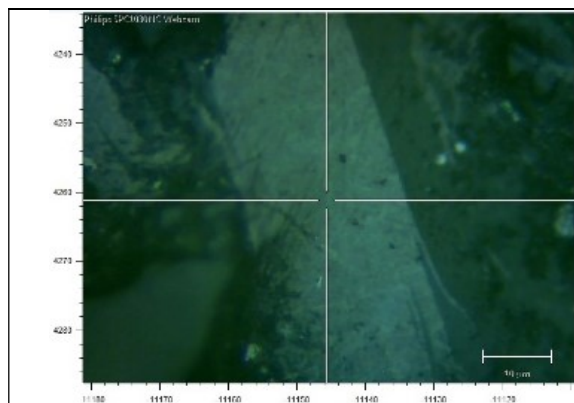
Raman analysis showing peaks of Vein Type Graphite in Sample no. 1

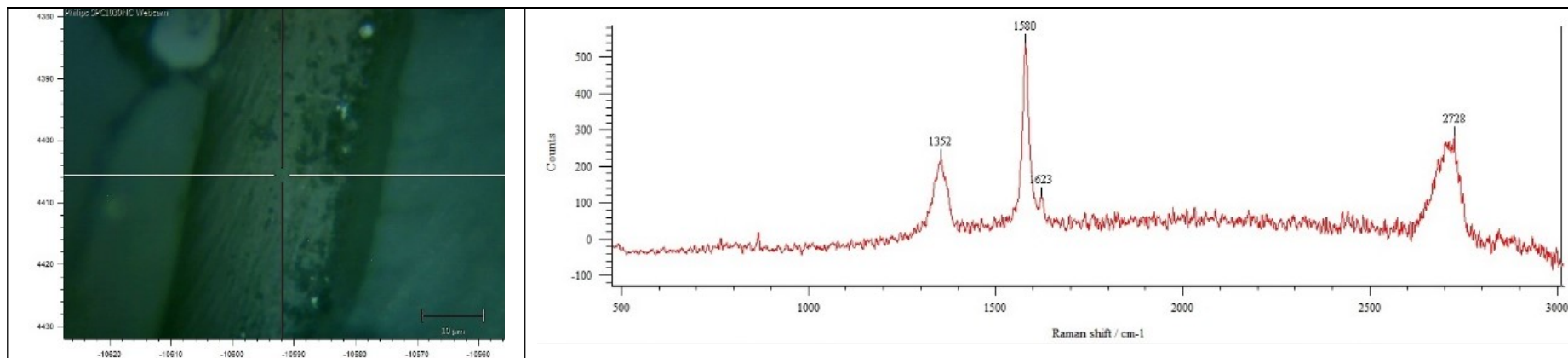




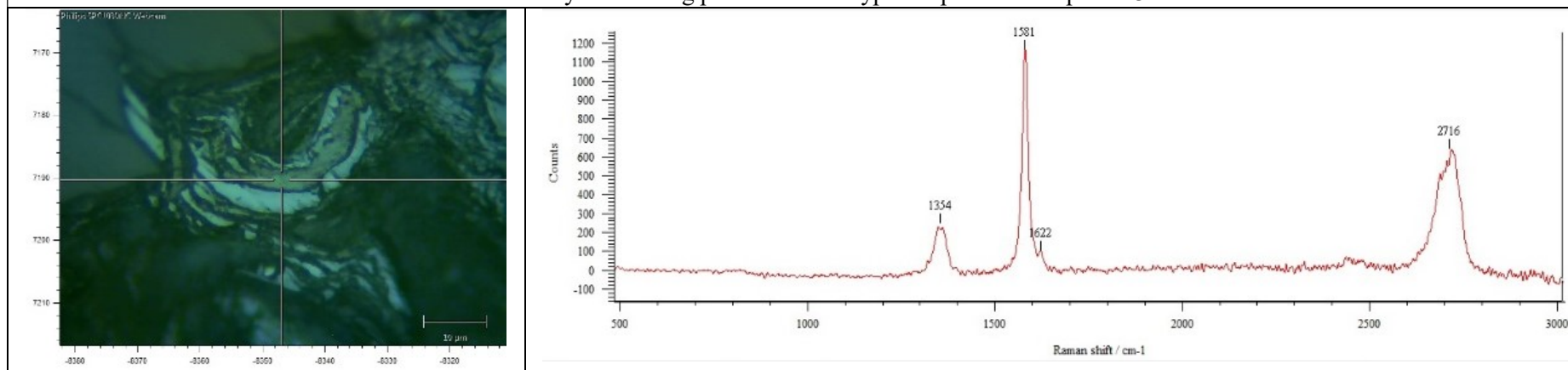


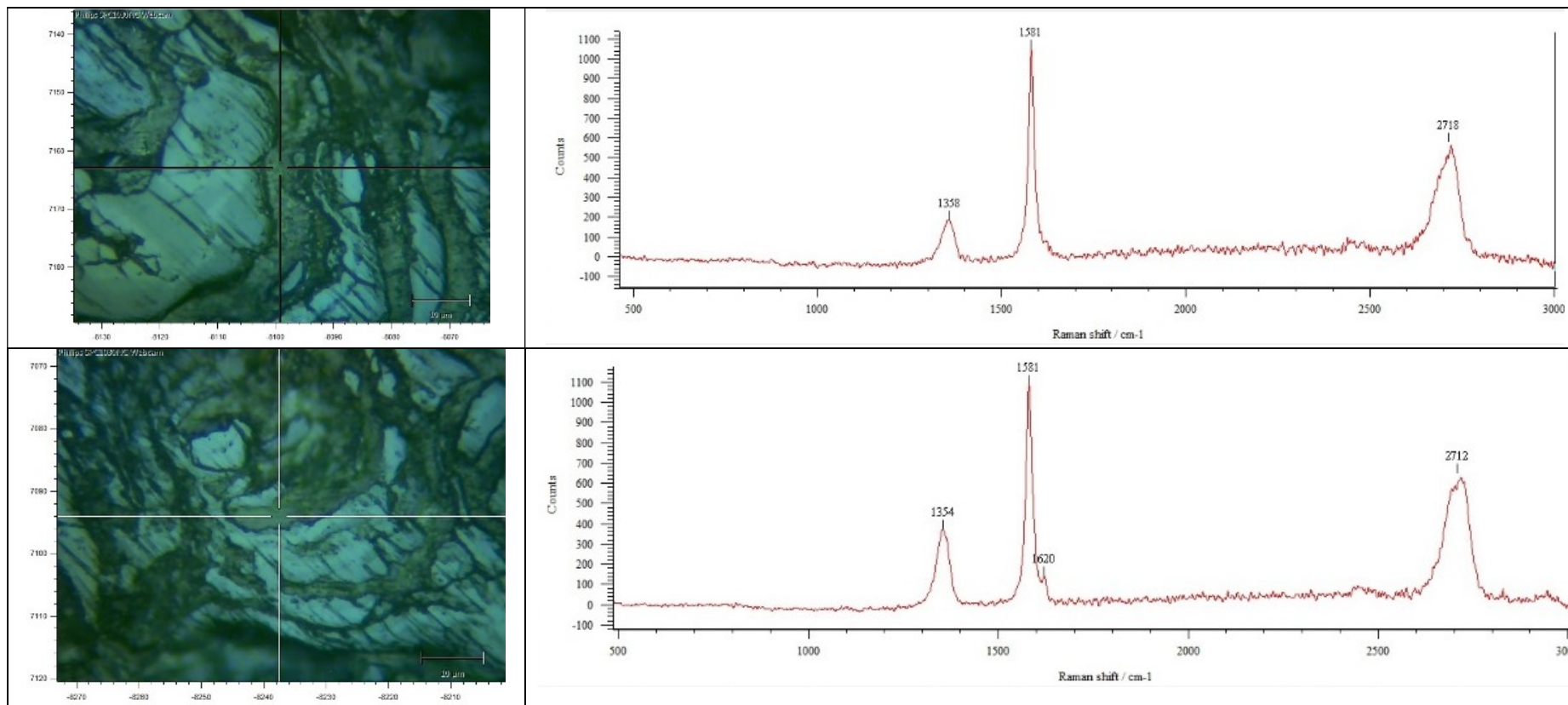


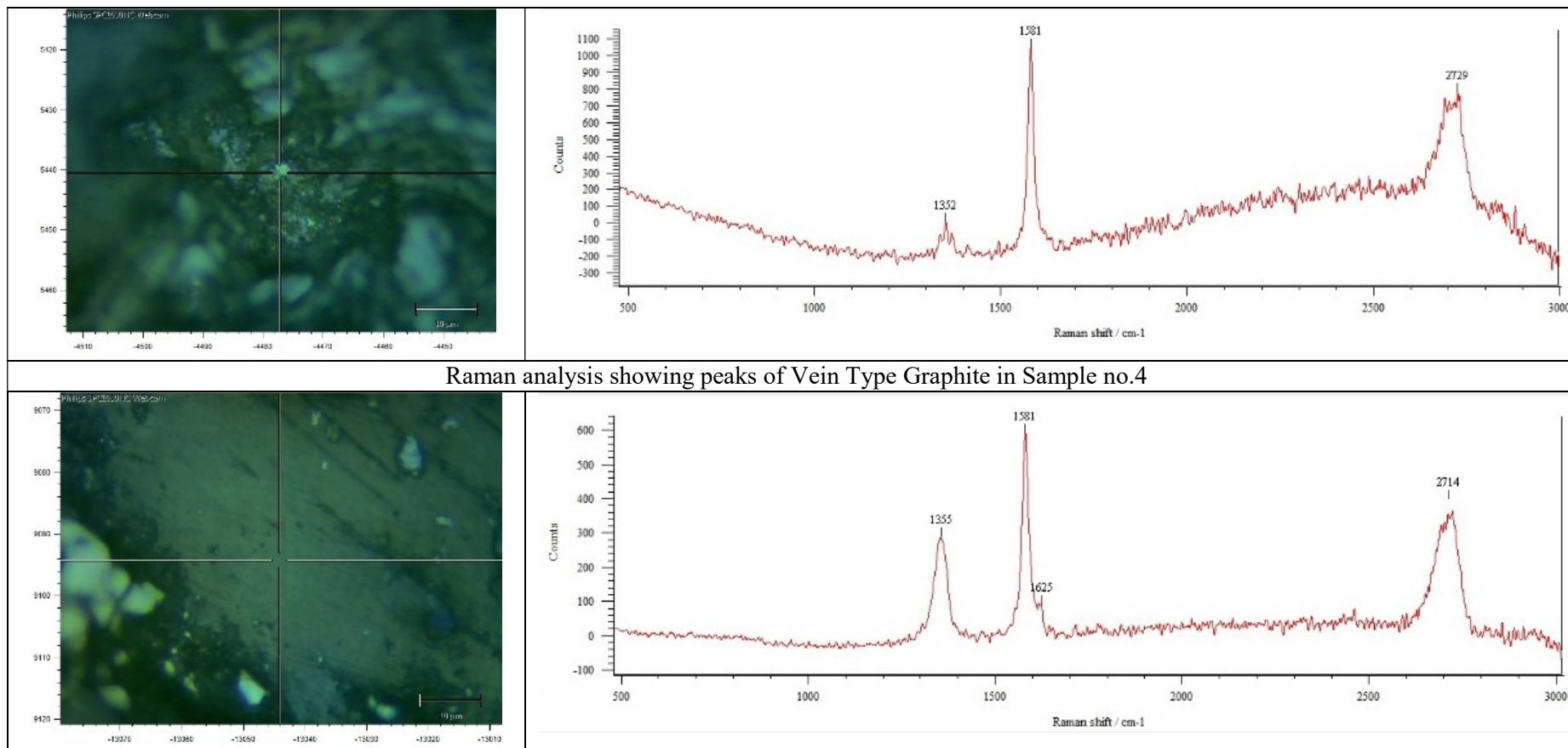


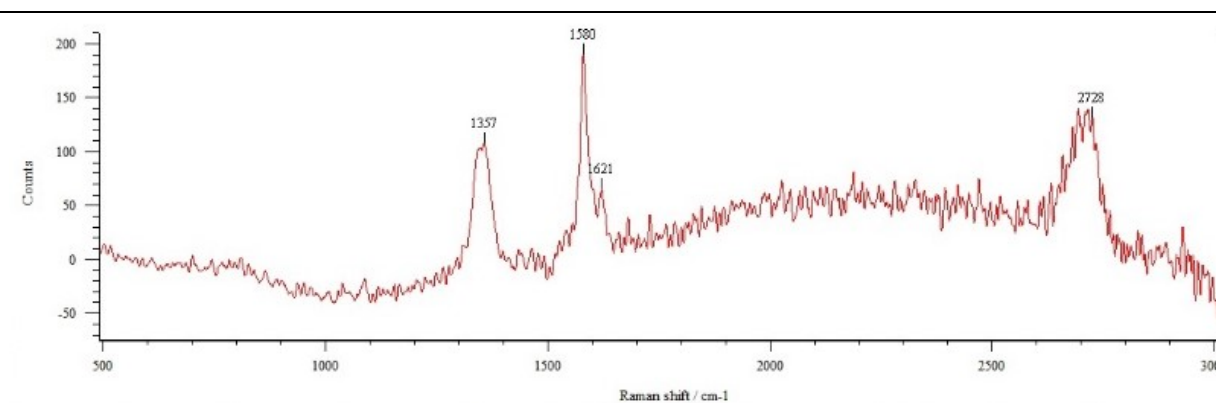
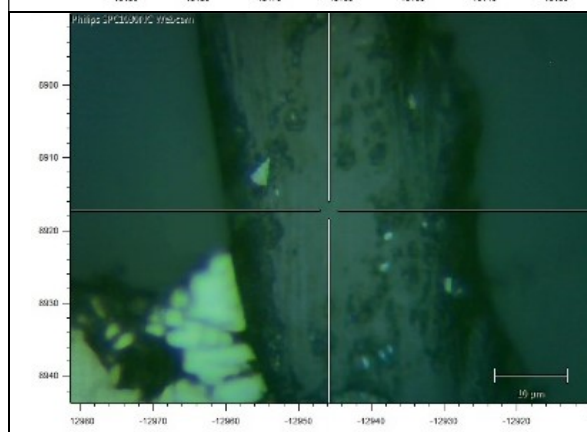
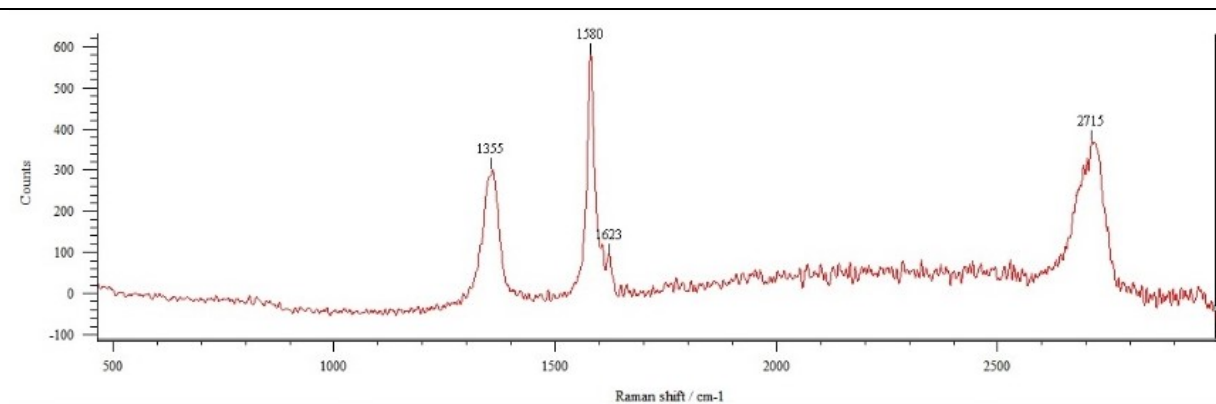
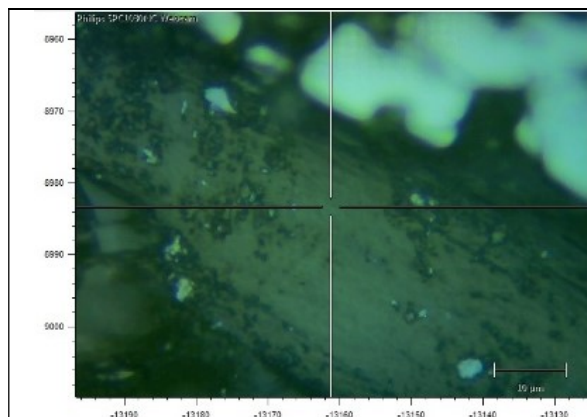


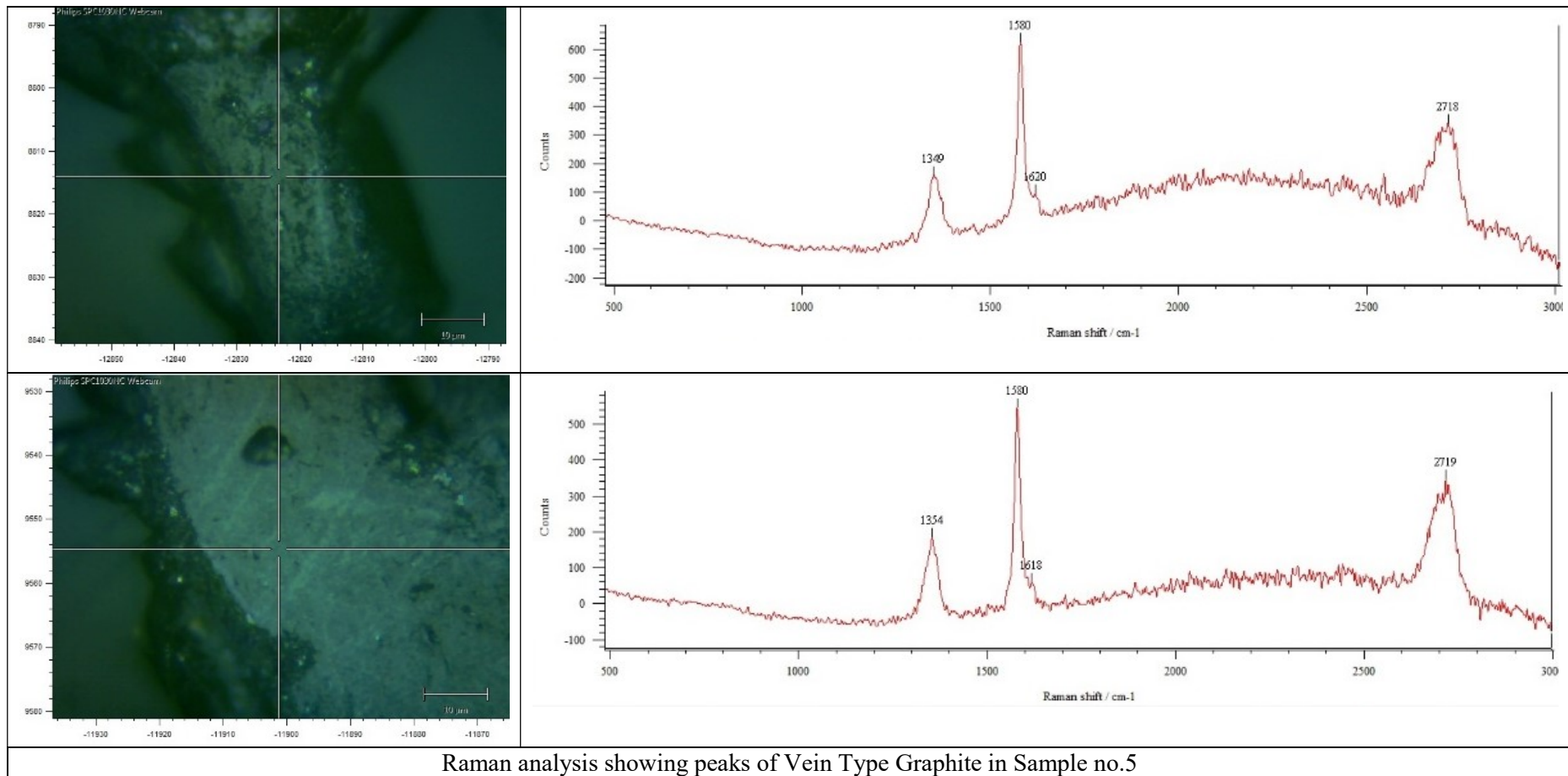
Raman analysis showing peaks of Vein Type Graphite in Sample no.3











Sample Analyzed by: Dr. Debjani Sarkar, Sr. Geologist, NCEGR, Kolkata

Reference

Neubeck, A., Broman, C., Magnus Ivarsson, M., Holm, N. G., Martin Whitehouse, Sara Nilsson, Wolf Geppert and Fernando Gervilla (2020) Isotopic Signatures of Carbon in the 'Los Pobres' Graphite Mine, Ronda, Spain. *Journal of Petrology*, Vol. 61-4, pp 1-13.

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Zhang, He., Qian, G., Yunafeng Cal., Gibson, C., and Pring, A. (2022) Crystal chemistry of the arsenian pyrites: A Raman spectroscopic study. *Journal of American Mineralogist*, Vol. 107, pp 274-281