The Ø 40 x 33 km Pilbara Crater near Port Hedland (NW-Australia)

- RAMAN Spectra of selected Rock Samples - by Harry K. Hahn, 30.6.2021 -

Raman spectra of quartz samples collected at the sample sites **25, 11** and **10** provide first evidence for this Ø40x33km elliptical Impact Crater and for the secondary impact-structures produced by this crater

The impact crater is located near the town Port Hedland in Western Australia. Because of the ellipical shape of the crater it is the result of an oblique impact. That means the impactor which formed the crater impacted in a very shallow angle of probably less then 10°. → **Here my more detailed : Study**

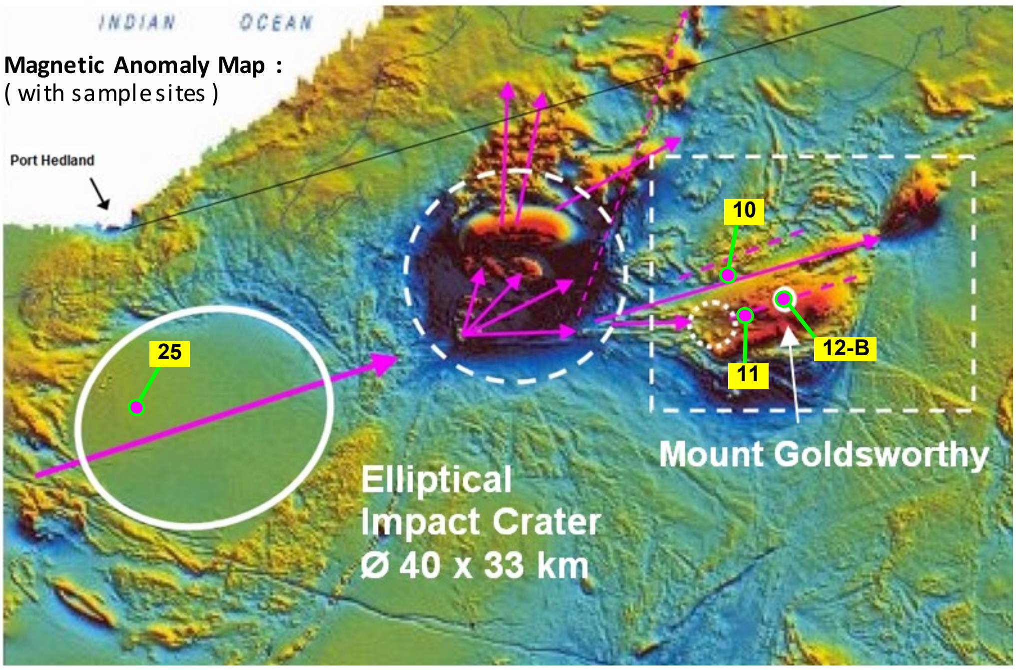
Because of the shallow impact angle, fragments of the impactor were ejected from the crater and caused complex secondary impact structures 40 km and 80 km further east of this elliptical crater. One of the secondary impact structures is Mount Goldsworthy which is a famous Iron Ore Mine that contained the world's richest deposits of ferrous (iron)-ore with a share of up to 68 % iron.

Beside the Raman spectra which I present as evidence and first verification for this elliptical crater and its secondary impact structures, there is additional geo-physical evidence coming from the magnetic anomaly map (see image below), which clearly indicates the elliptical crater, including a center-line structure in the crater, and which shows the secondary impact structures in detail.

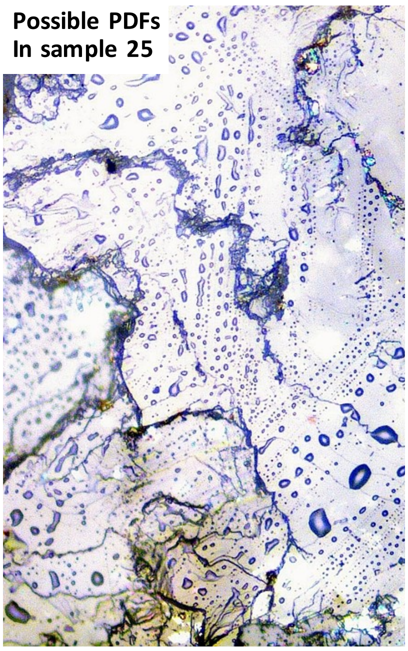
The shifts of the main Raman bands (peaks) to the lower frequencies **463, 261, 198/205** and **125 cm^{-1}** in a quartz sample from the sample site 25 (Stone 2), which was collected inside the crater area, clearly indicates that the quartz was exposed to a **shock pressure of arond 22 GPa**. (see explanation in the Appendix at **page 19**). Further evidence for an impact event is provided by quartz samples from sample sites 10 & 11 which are located in the area of the secondary impact-structure Mt Goldsworthy. These quartz samples show shifts of the main Raman bands (peaks) to the lower frequencies **463, 260, 204** and **126 cm^{-1}** which also indicates a **shock pressure of around 22 GPa**. Further evidence comes from a microscopic image of sample 25 (stone 3) which indicates planar deformation features (PDFs). All spectra were made with a **BRUKER Senterra-II Raman Microscope** (wavenumber precision <0.1cm^{-1})

A shock pressure of 22 GPa far exceeds every pressure caused by normal terrestrial metamorphism. Therefore the quartz from the sample sites 25, 11 and 10 was clearly shocked by an impact event. The indicated shock pressure of ≈ 22 GPa is lower than the shock pressure that occured in other large impact craters on Earth, which can reach 100 GPa. This points towards an oblique impact. That means the impactor which formed the impact crater (→ possibly a fragment of the PTI-Impactor) impacted in a very shallow angle of probably less than 10 degree, with a relatively low impact velocity of < 10 km/s.

→ Images of the analysed rock samples and photos of the sample sites are in the Appendix at **page 17.**
→ A general summary to all analysed sample sites is provided by **Part 6** (**P6**) of my **PTI-hypothesis** (**P1**)
→ More images of all sample sites are available on www.permiantriassic.de or www.permiantriassic.at

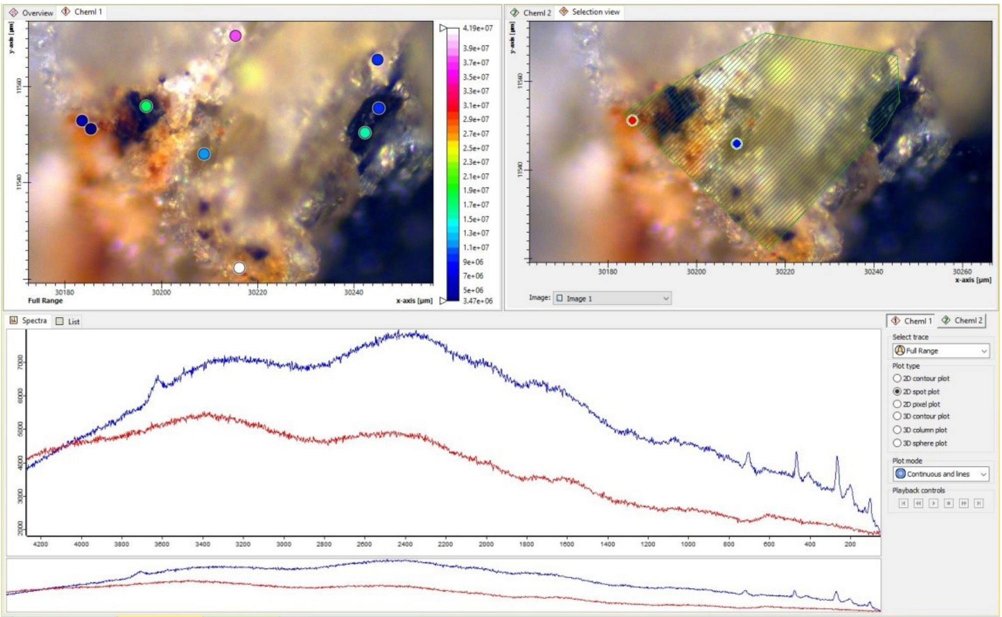


Possible PDFs
In sample 25



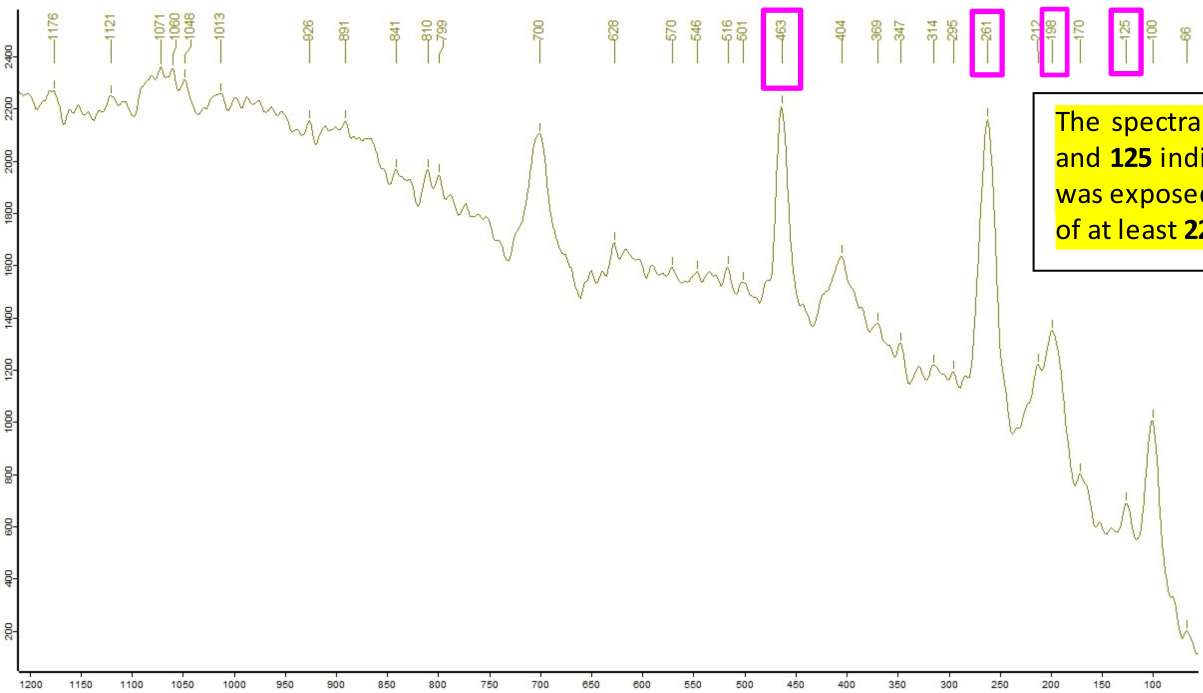
Sample Site 25 : Stone 2_spectra 2 indicates : Quartz & Trilithionite, Muscovite (→ see RRUFF_CS results)

The Spectrum indicates a mixture of Quartz and Trilithionite / Muscovite



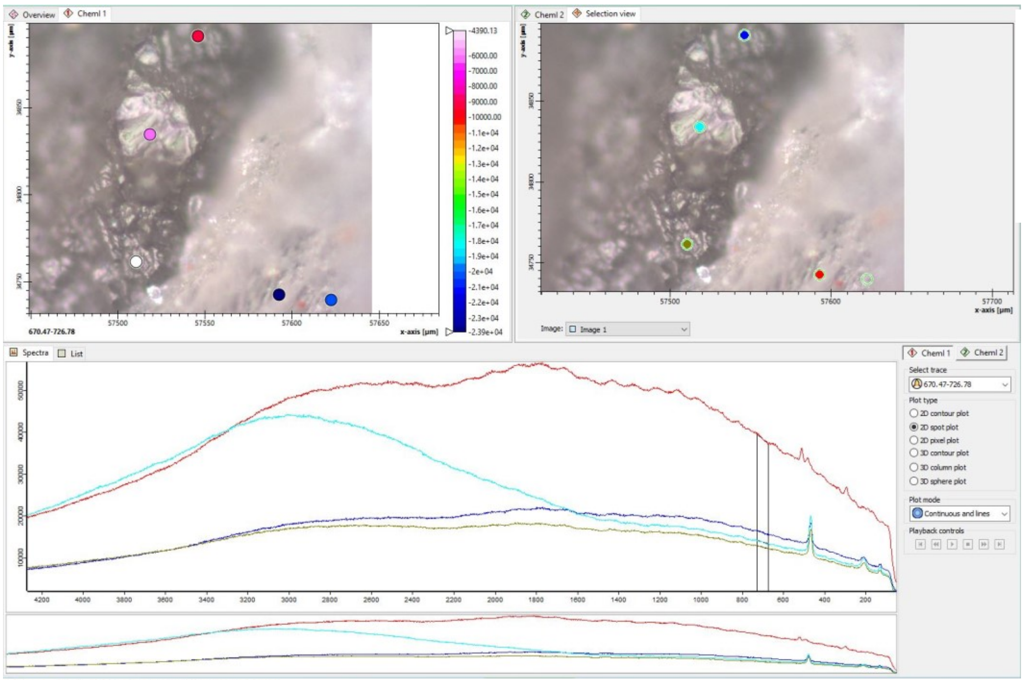
Sample :

Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463, 261, 198 and 125

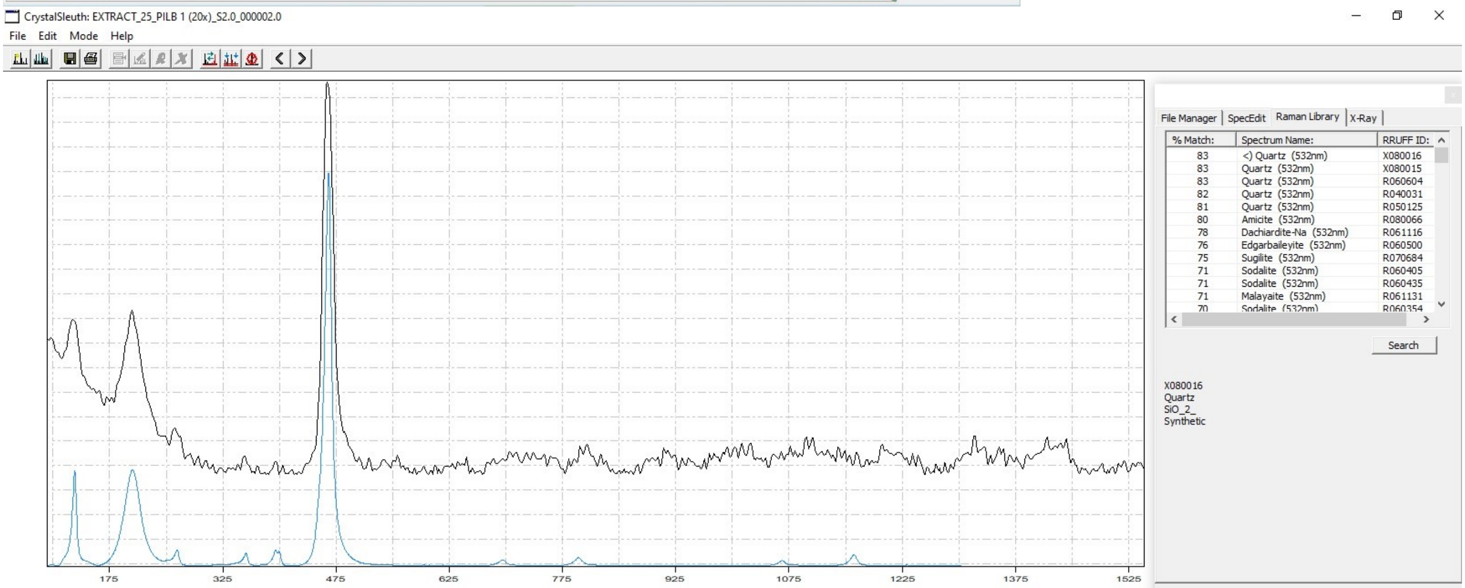


The spectral lines **463, 261, 198** and **125** indicate that the Quartz was exposed to a shock pressure of at least **22 GPa**

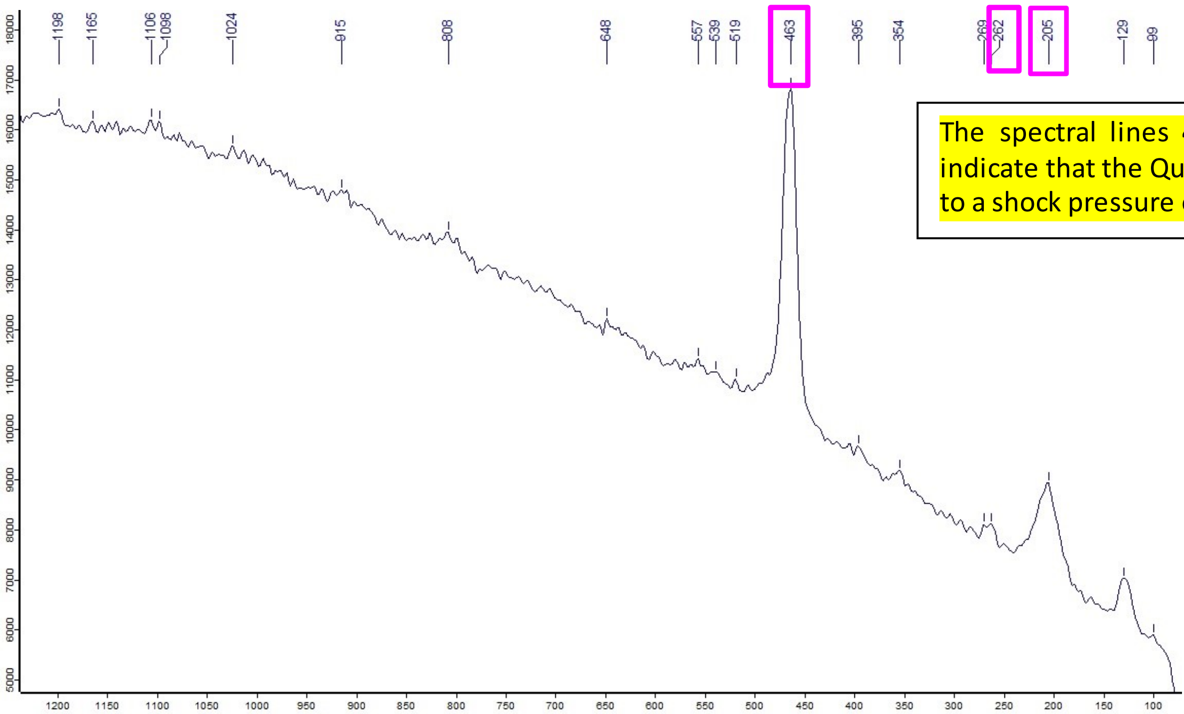
Sample-Site 25 : Stone 2_spectra 3 indicates : Quartz (→ see RRUFF_CS results)



Sample :

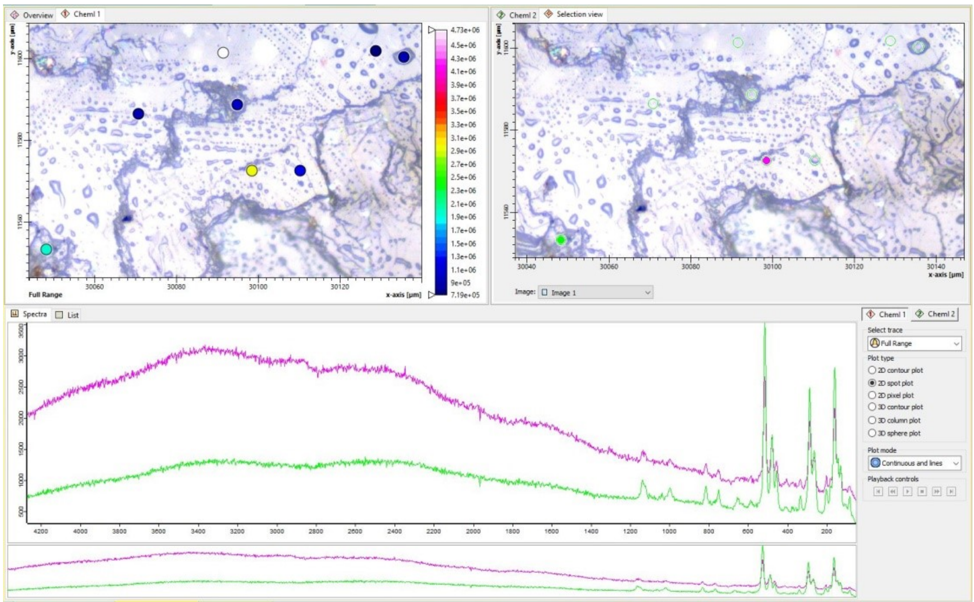


Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463, 262 and 205



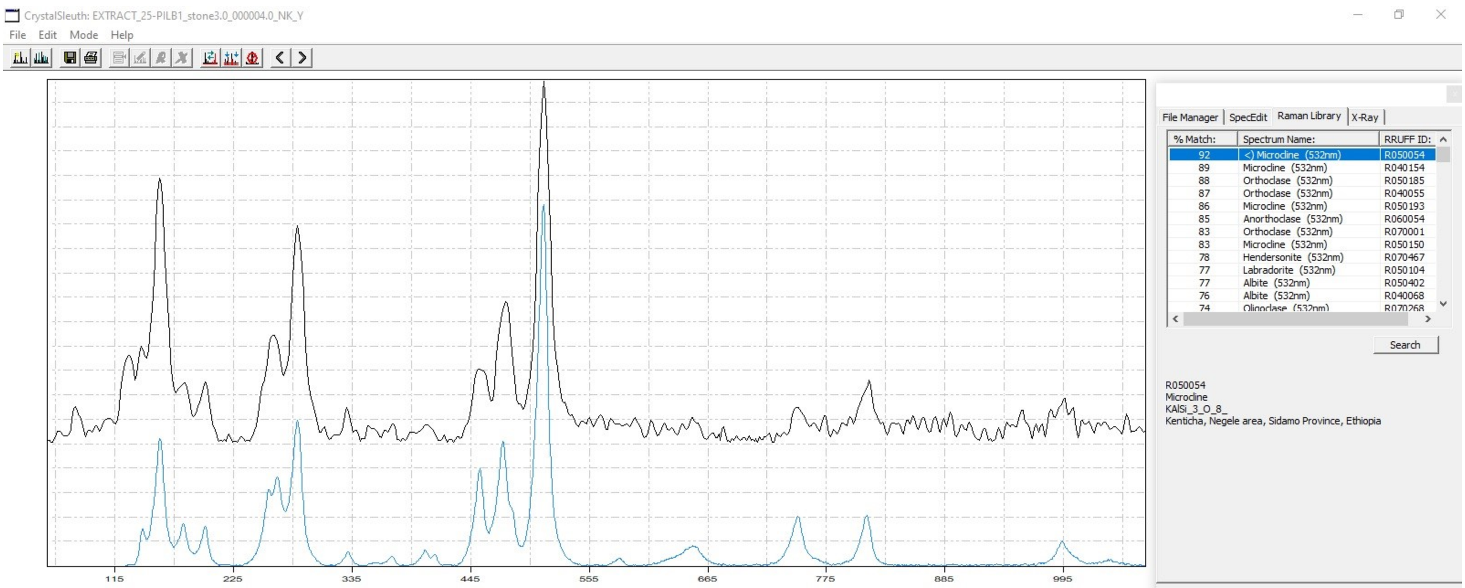
The spectral lines **463, 262** and **205** indicate that the Quartz was exposed to a shock pressure of around **22 GPa**

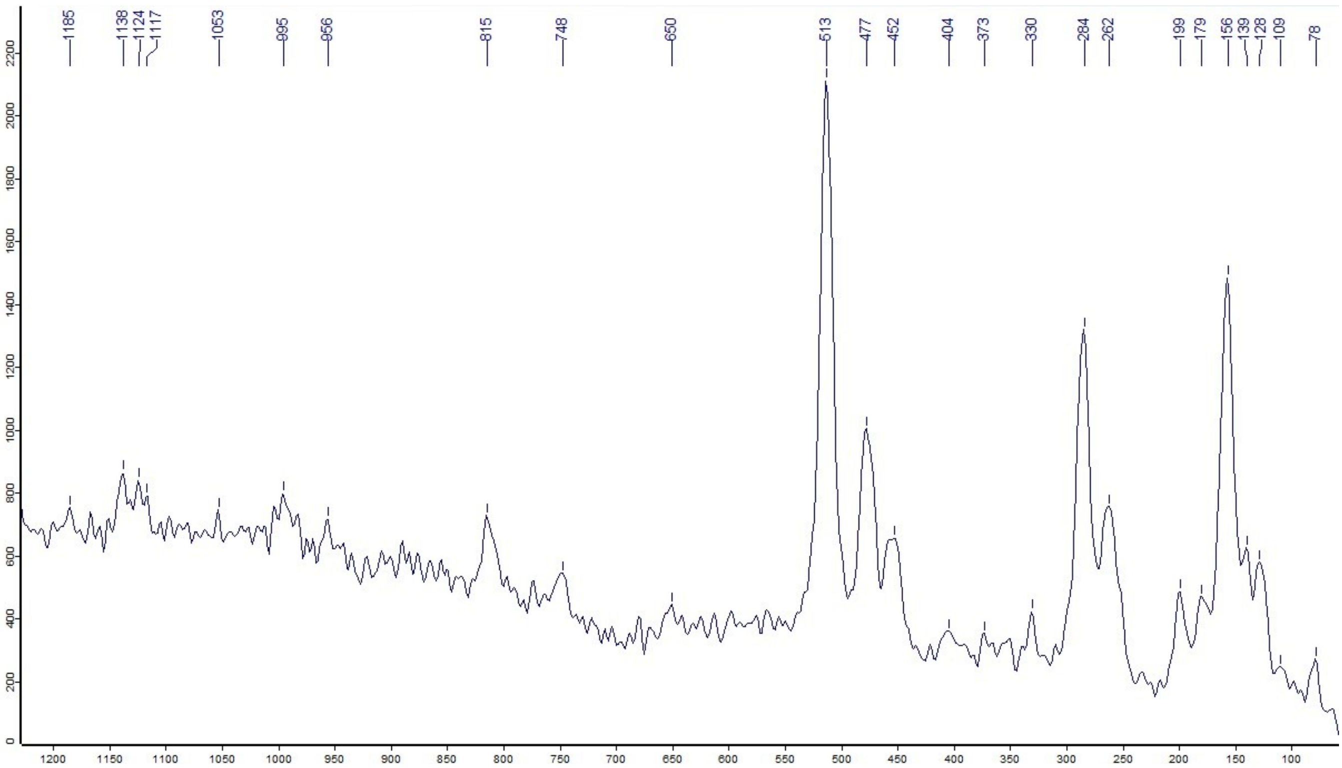
Sample Site 25 : Stone 3_spectra 2 indicates : Microcline (→ see RRUFF_CS results)



Note the sets of parallel fractures in the microscopic image, which are orientated in defined angles to each other ! This indicates PDFs (Planar Deformation Features) in the sample

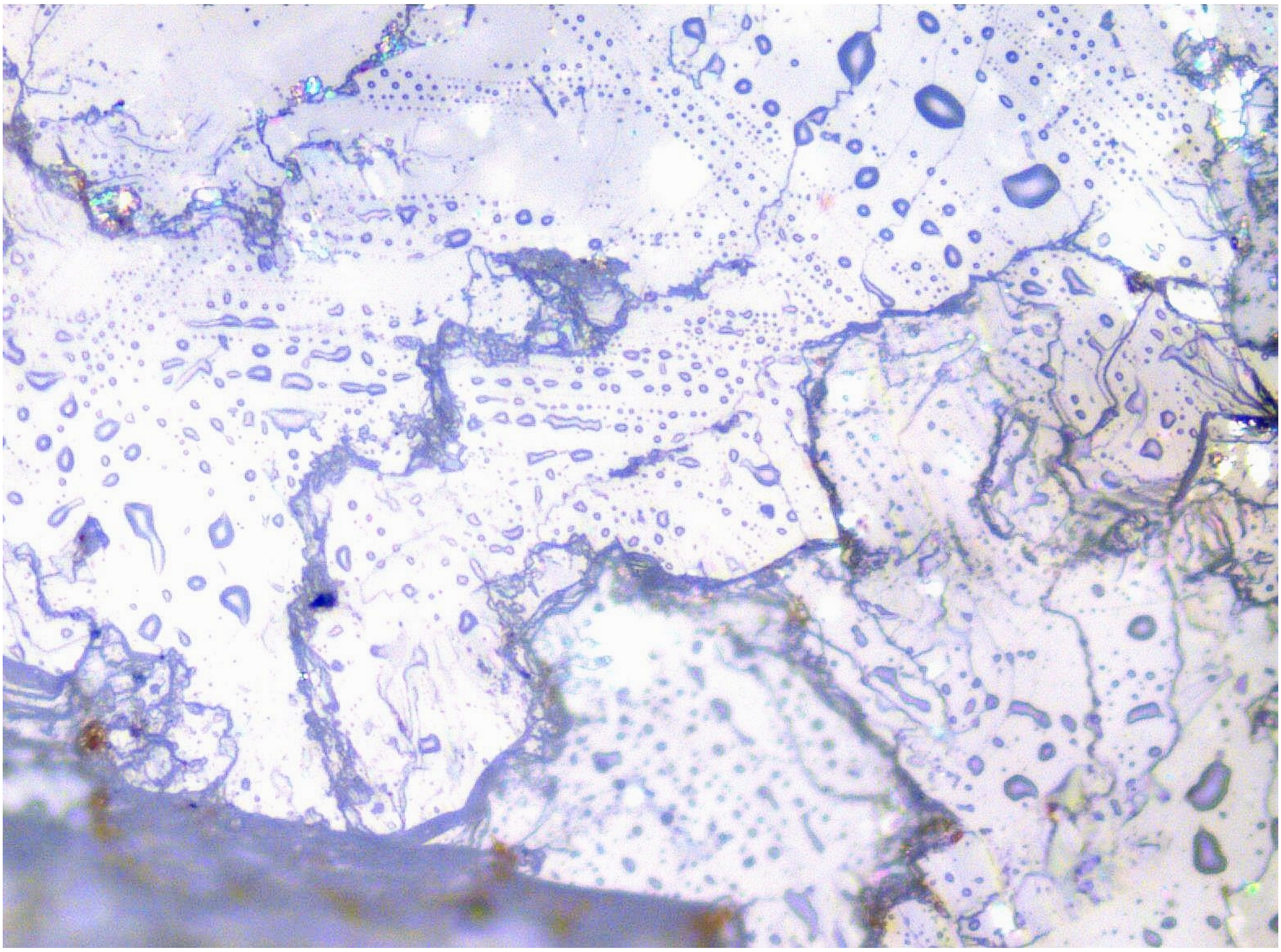
Sample :





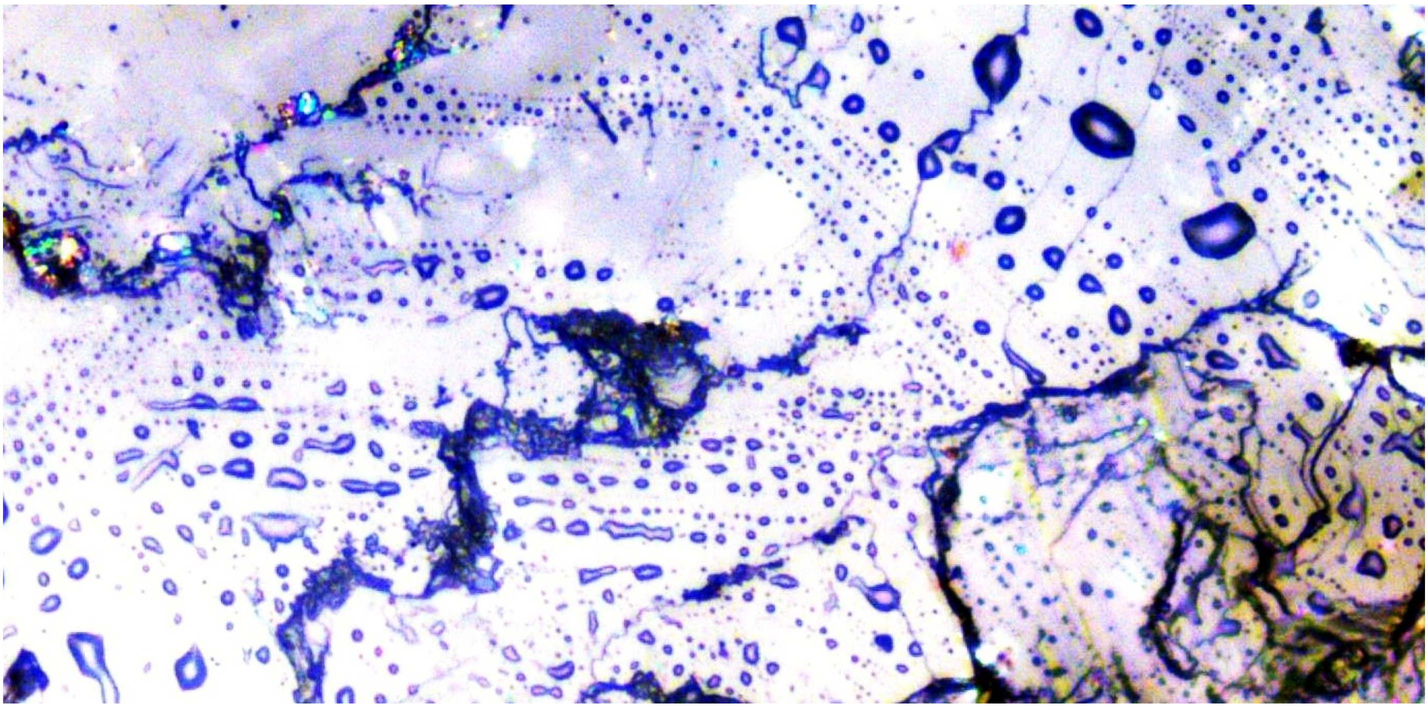
Microscopic Images : Sample from Site 25 → original state (no preparation for analysis)

Sample Site 25 : Stone 3_spectra 2 : Microcline → PDFs visible in sample - Image size : ~ 120 x 80 µm



Sample Site 25 : Stone 3_spectra 2 : Microcline → PDFs Visible in sample - Image size : ~ 100 x 50 µm

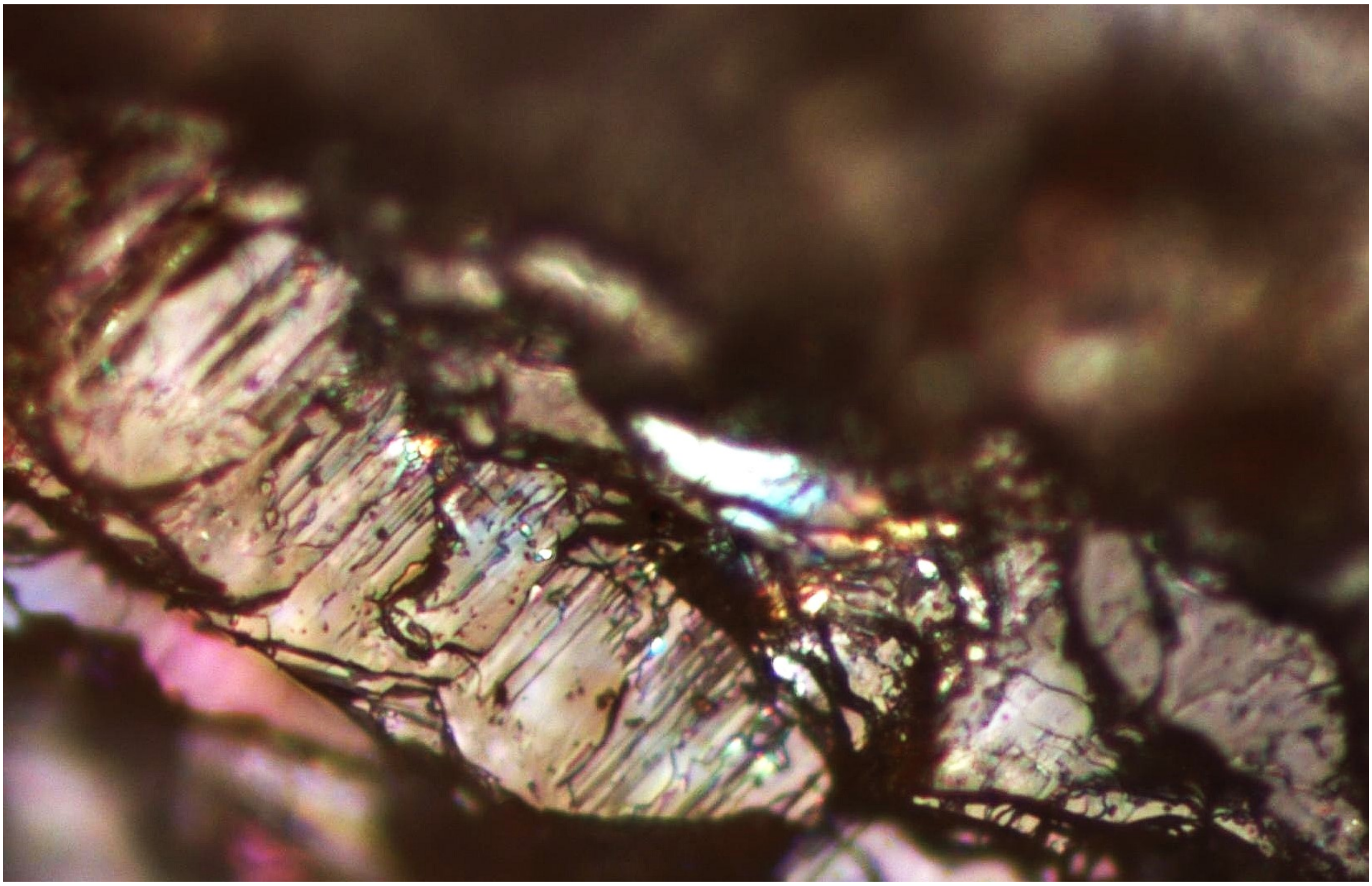
Detail : sets of parallel fractures which are orientated in defined angles to each other ! Indicating PDFs in the sample



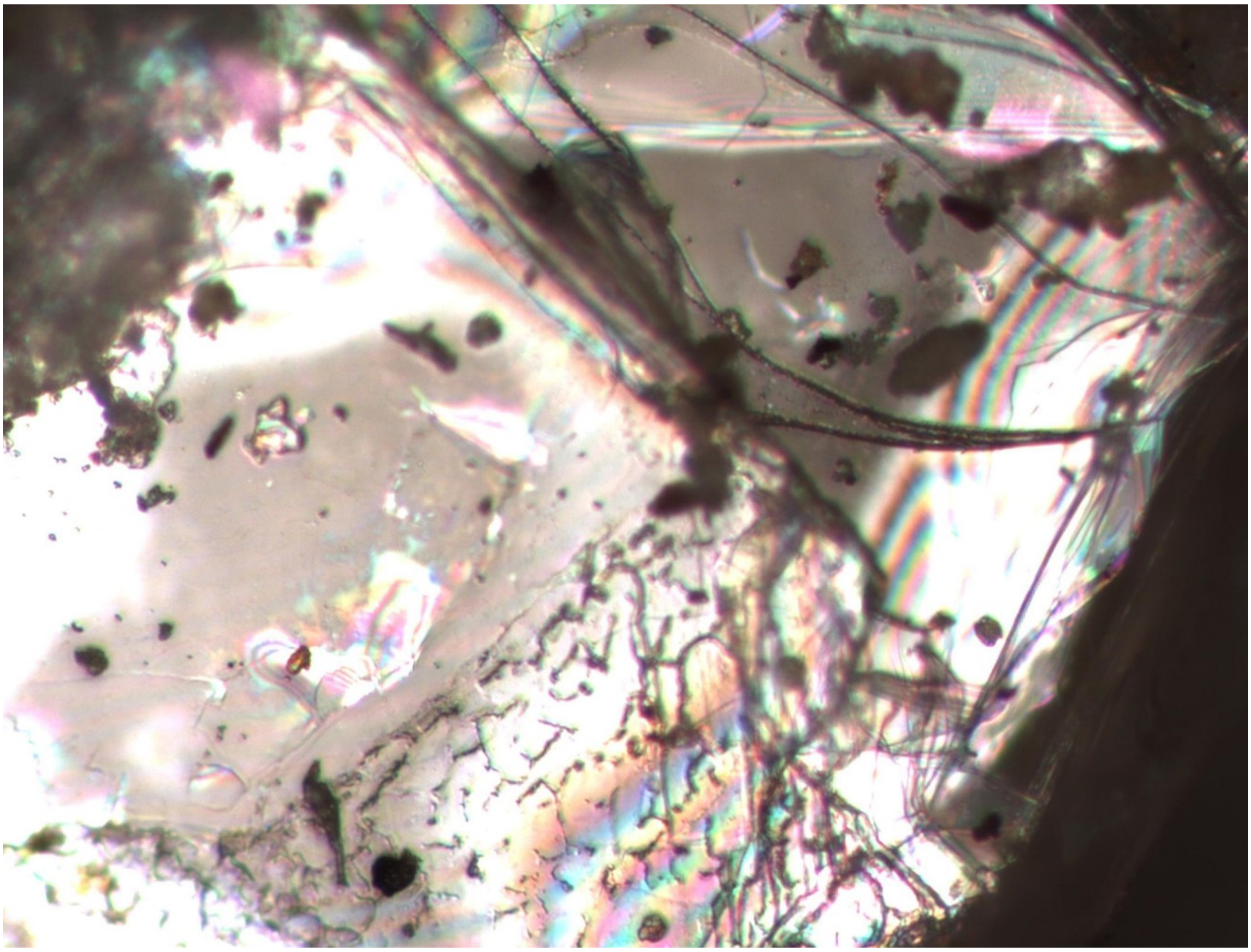
Microscopic Images : Sample from Site 25 → original state (no preparation for analysis)

Sample Site 25 : Stone 3 : Microcline, Orthoclase - Image size : ~ 150 x 100 µm

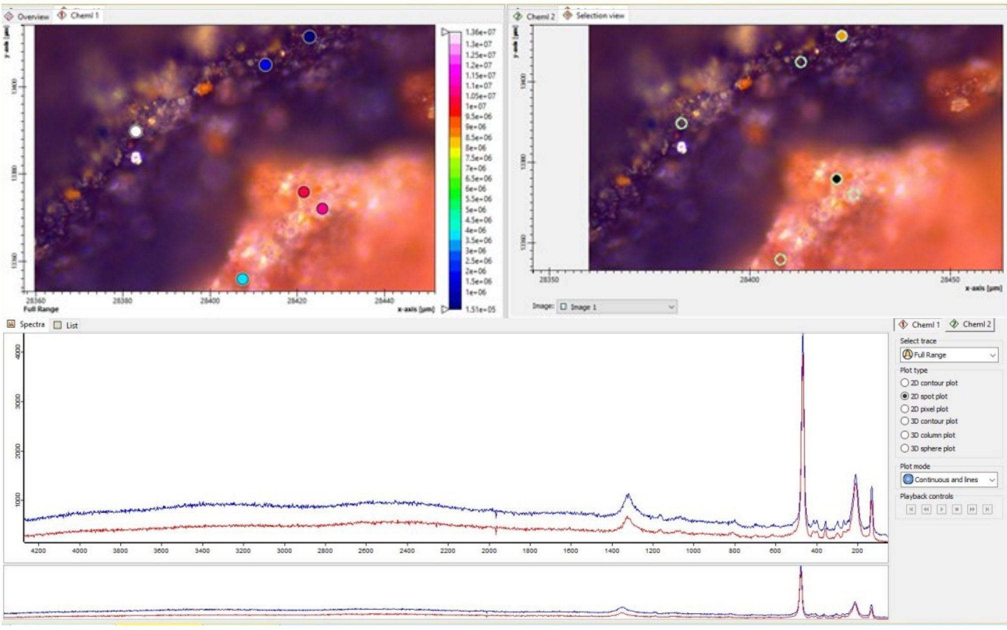
Detail : sets of parallel fractures which are orientated in defined angles to each other ! Indicating PDFs in the sample



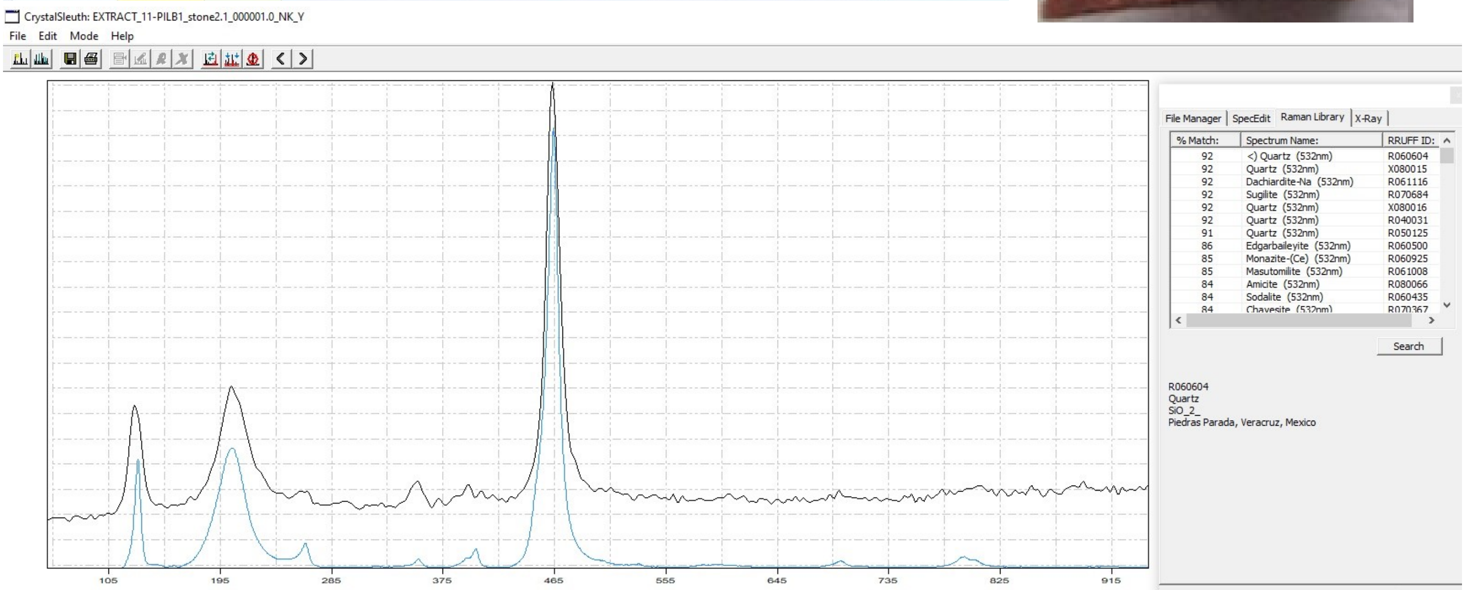
Sample Site 25 : Stone 2 : Quartz - Image size : ~ 200 x 150 µm



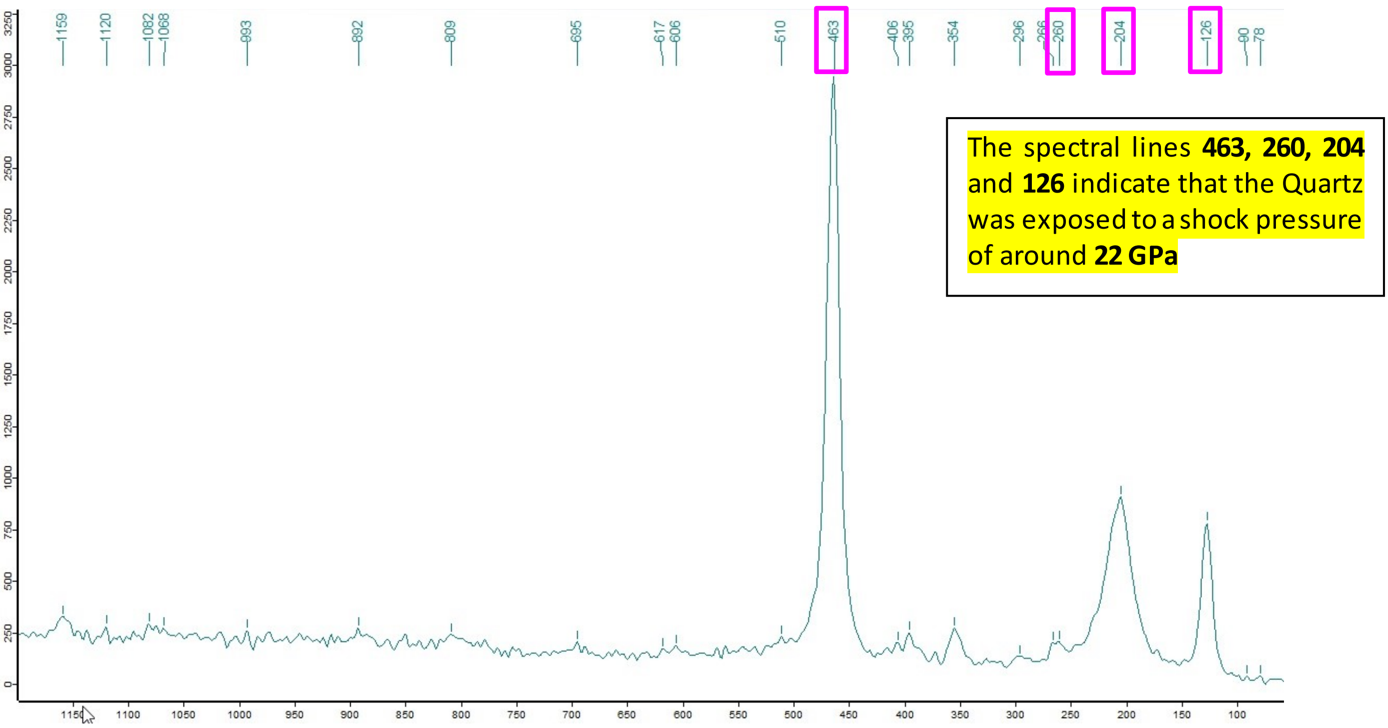
Sample Site 11 : Stone 2_spectra 1 indicates : Quartz (→ see RRUFF_CS results)



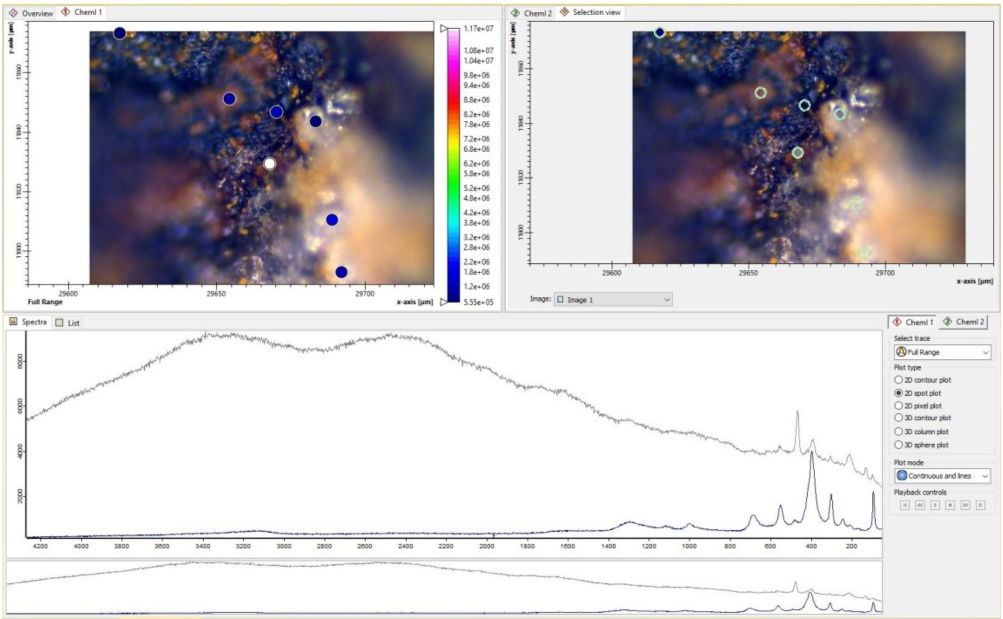
Sample :



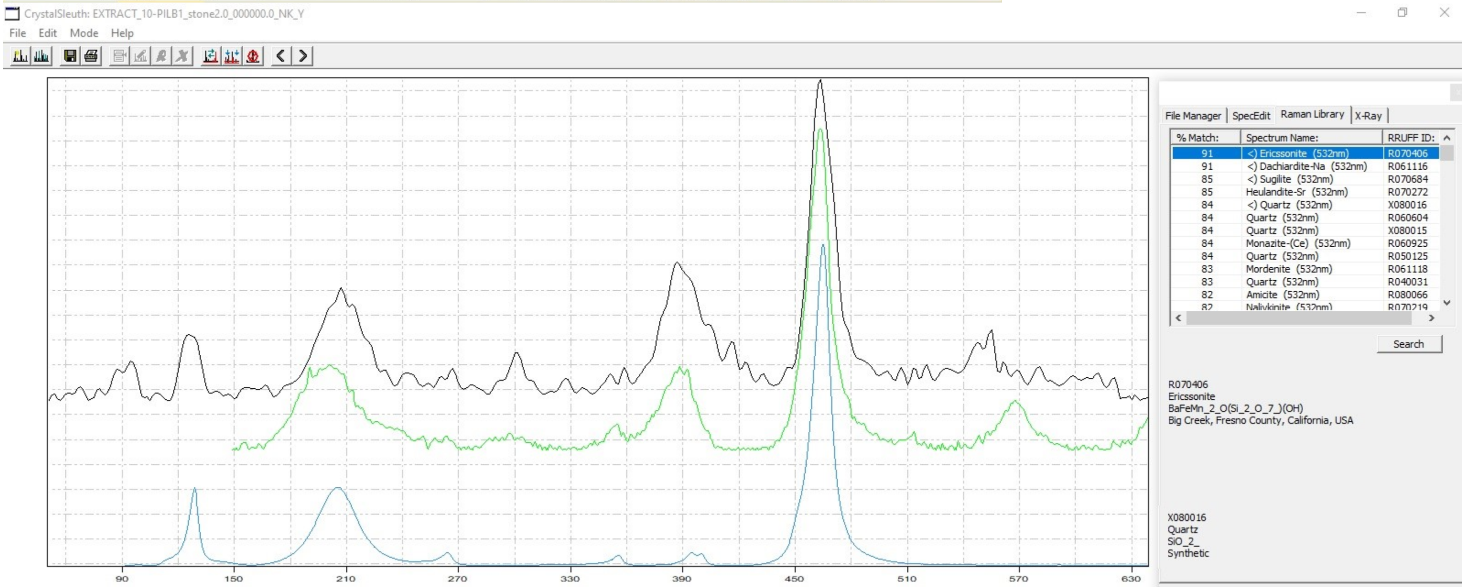
Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463, 260, 204



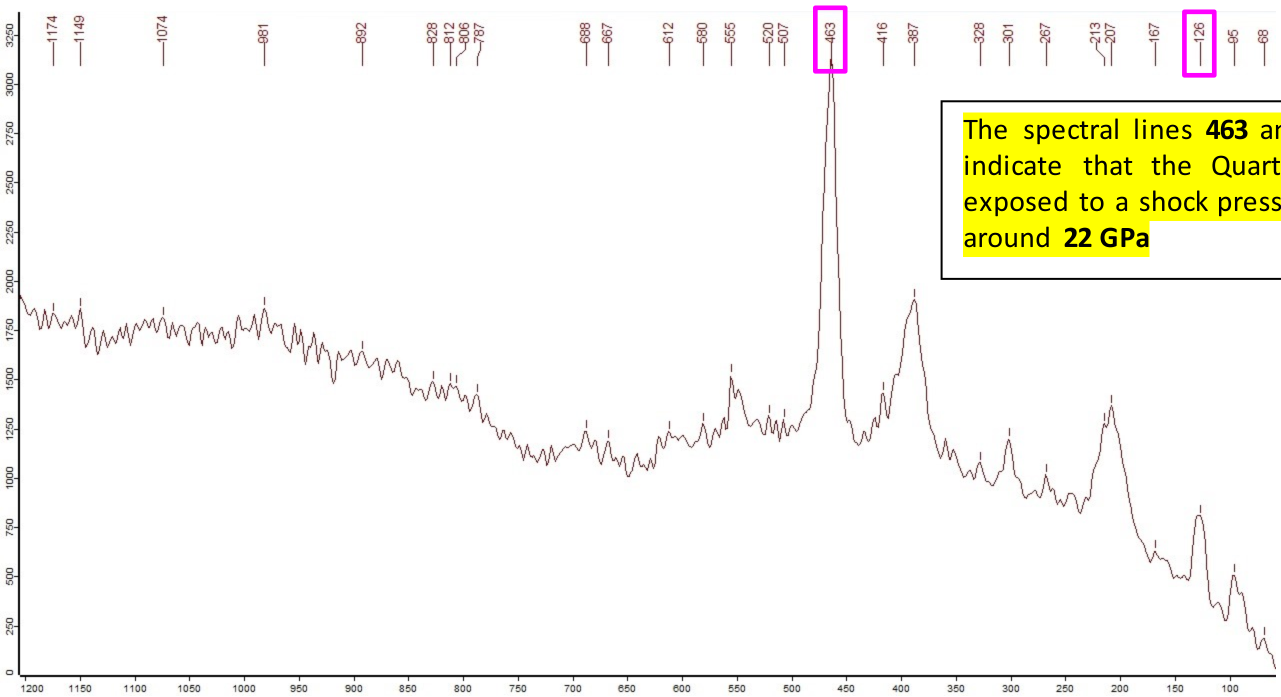
Sample Site 10 : Stone 2_spectra 1 indicates : Quartz , Ericssonite. (→ see RRUFF_CS results)



Sample :

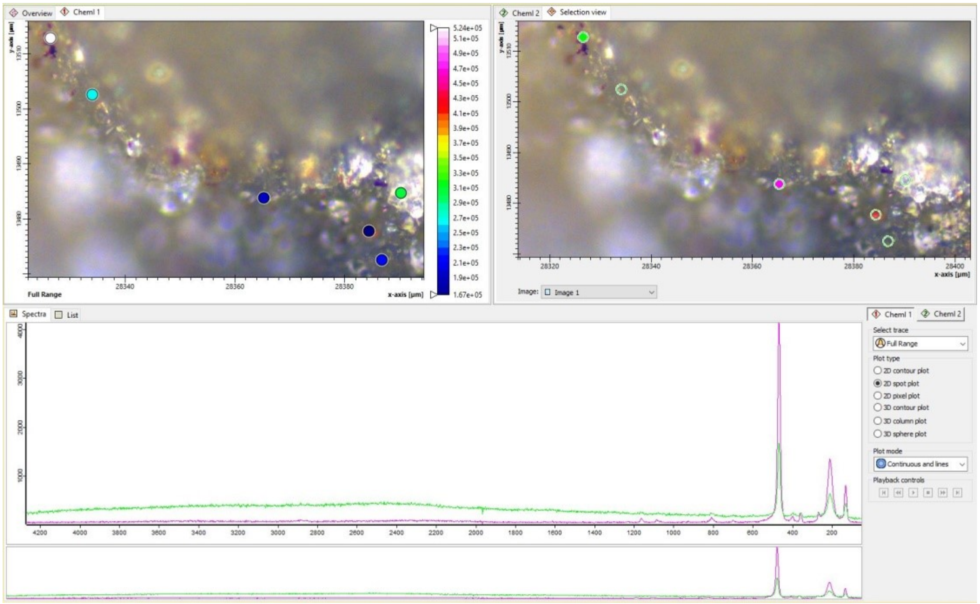


Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463 and 126



The spectral lines **463** and **126** indicate that the Quartz was exposed to a shock pressure of around **22 GPa**

Sample Site 12-B : Stone 1_spectra 1 indicates : Quartz (→ see RRUFF_CS results)



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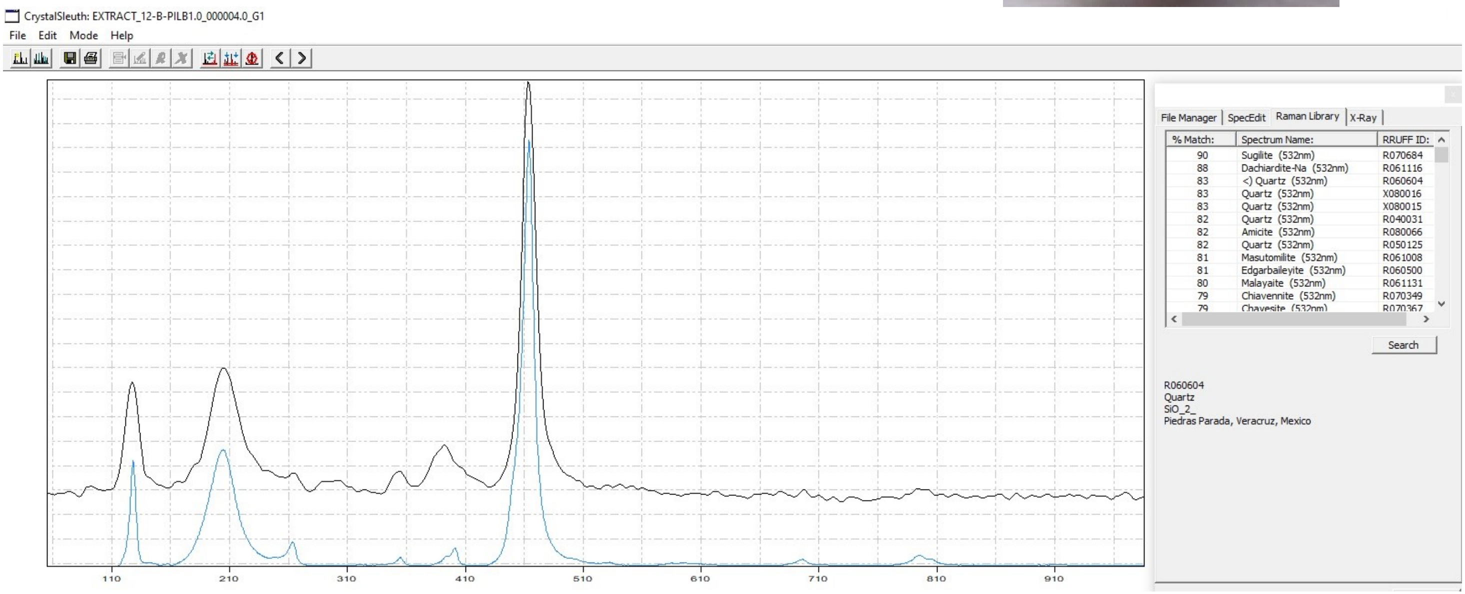
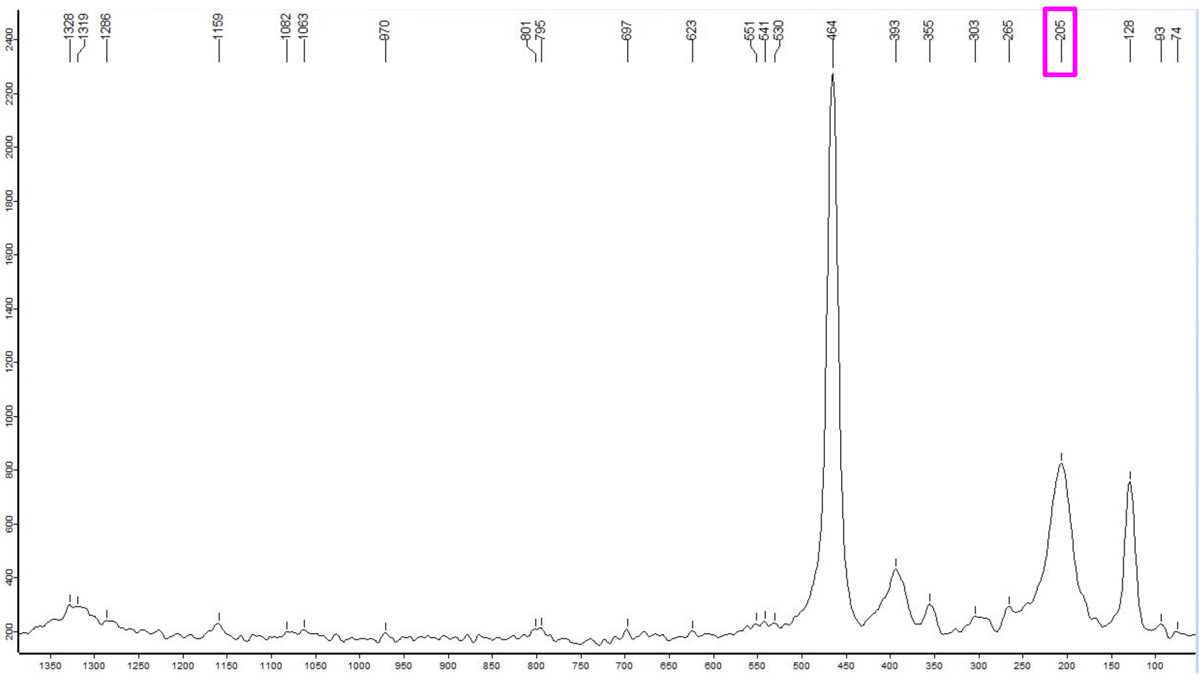
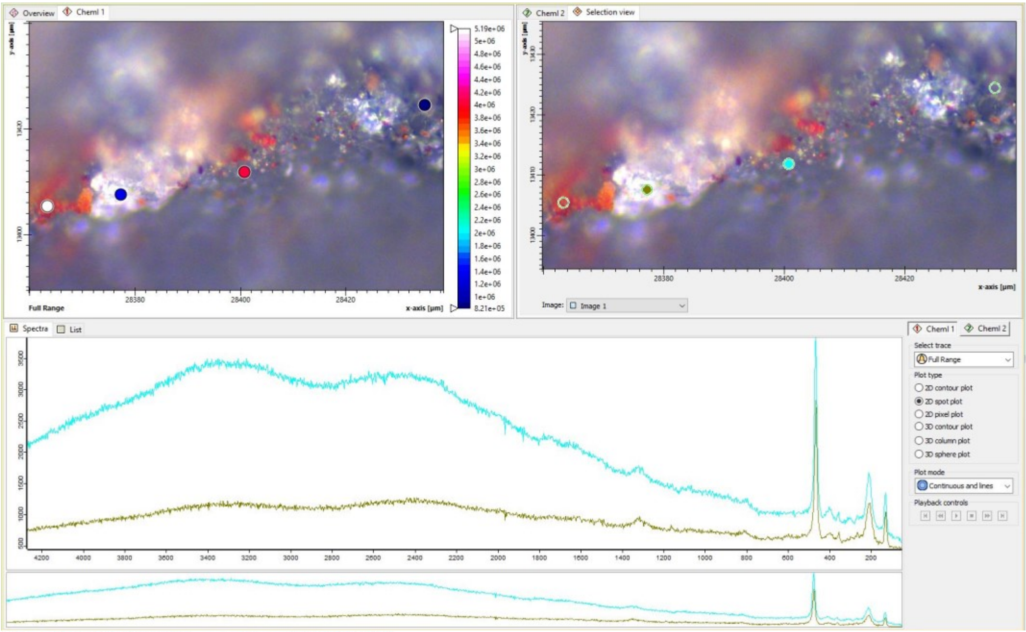
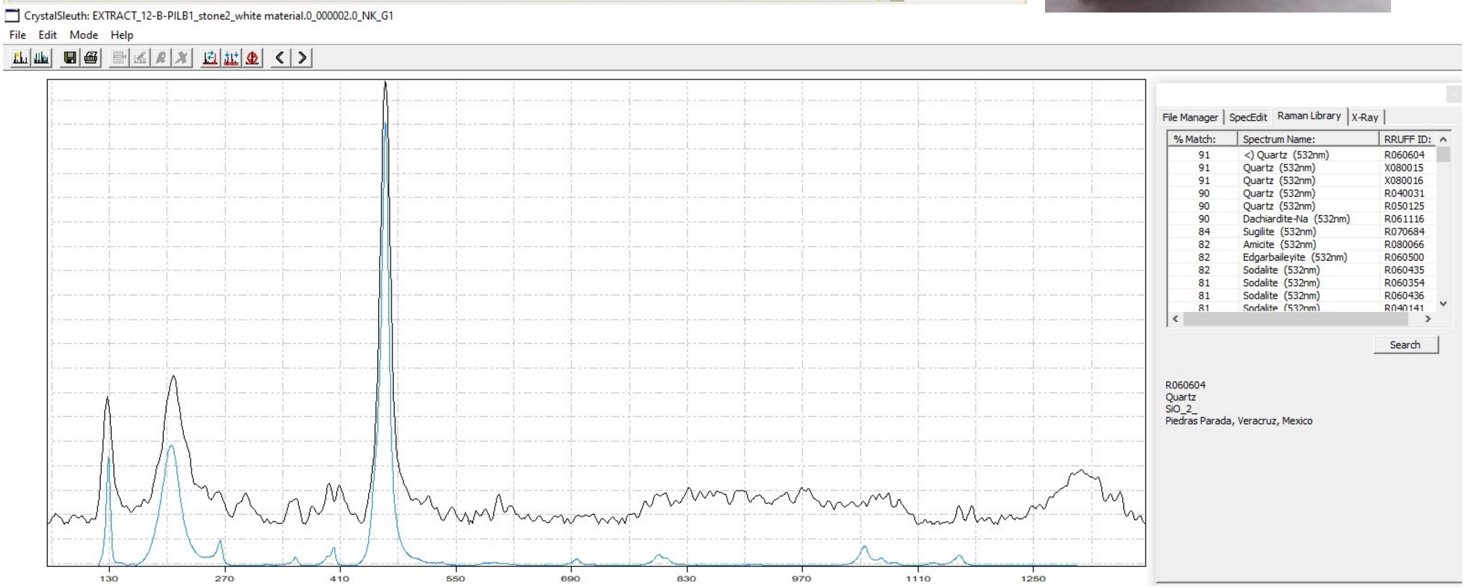


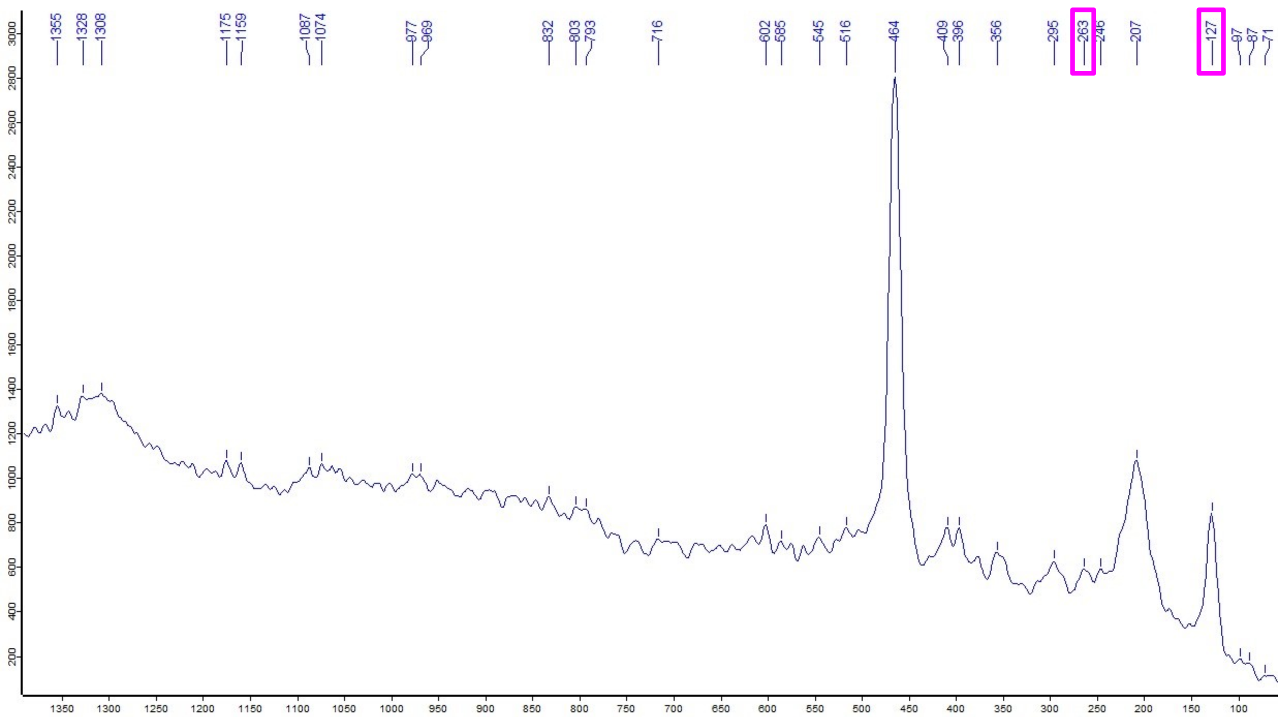


Sample Site 12-B : Stone 2_spectra 1 (white mineral) indicates : Quartz (→ see RRUFF_CS results)

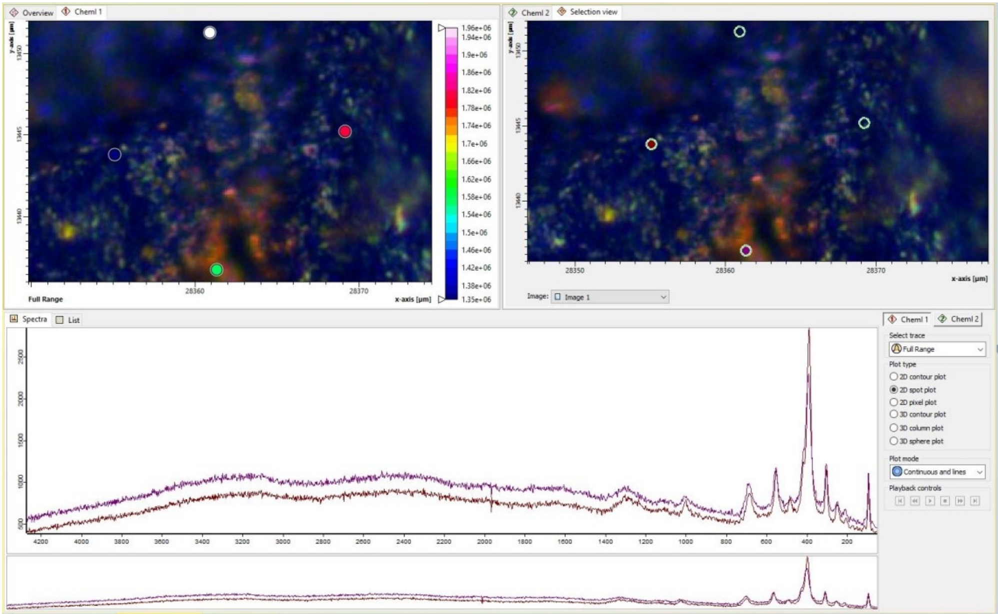


Sample :





Sample Site 10 : Stone 3_spectra 1 (dark mineral) indicates : Goethite , Chechite (→ see RRUFF_CS)



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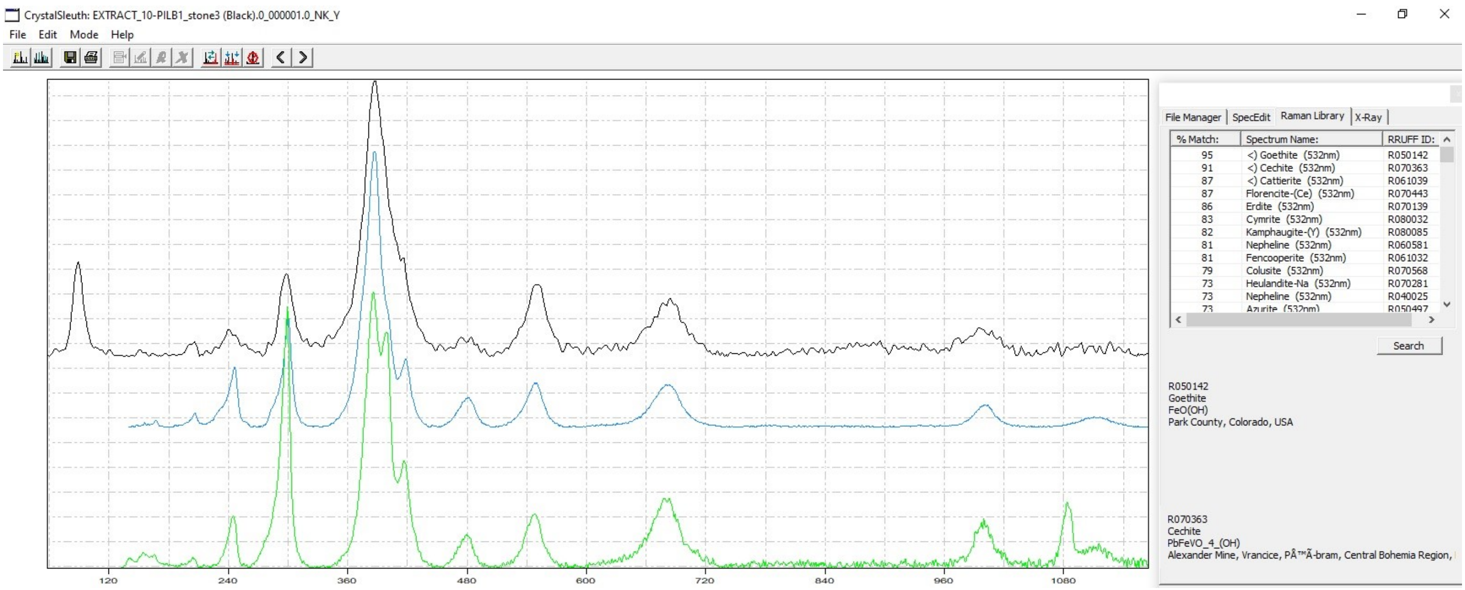
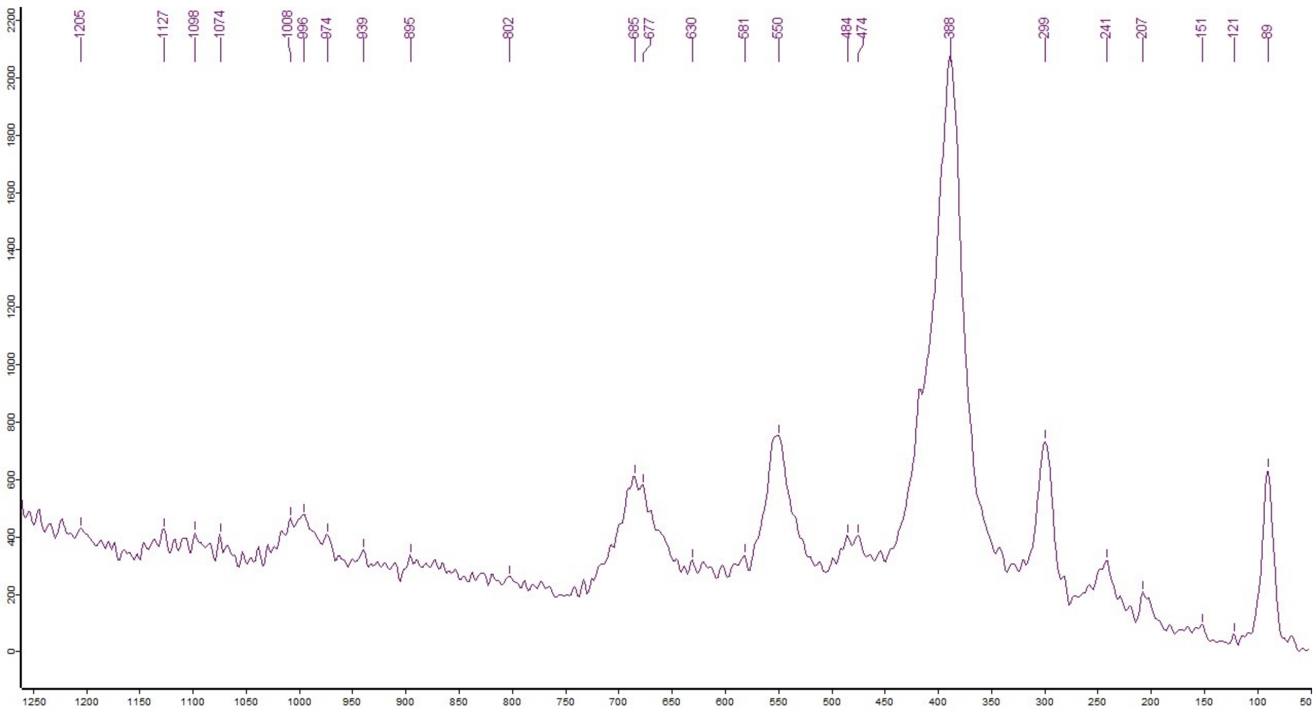
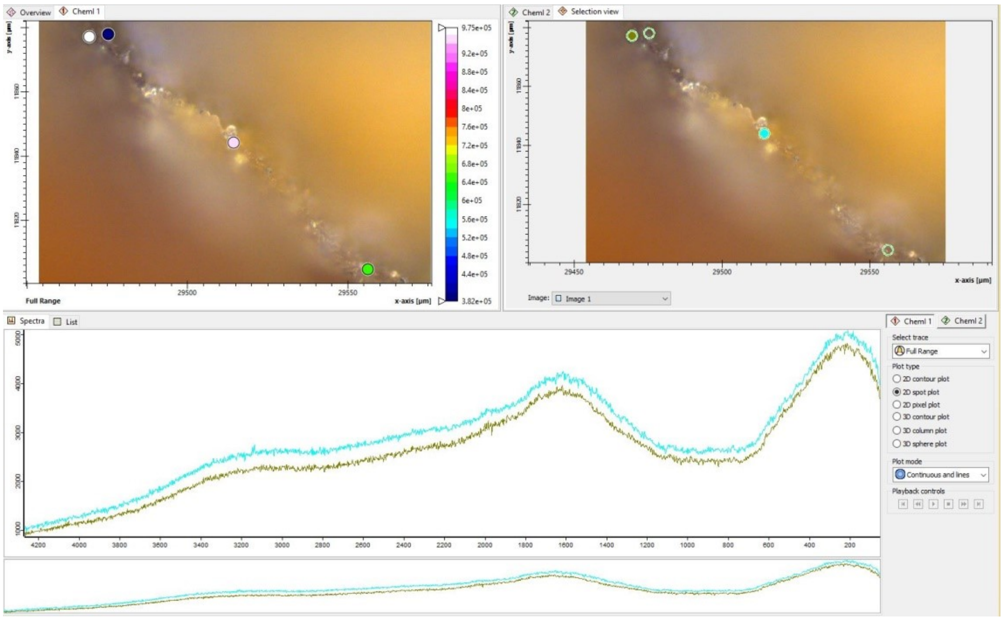




Sample Site 10 **: Stone 1_spectra 1 indicates :** (Anorthoclase, Orthoclase (Quartz) ?? (→ see RRUFF_CS results)
Spectra contains to less information ! No proper analysis possible.



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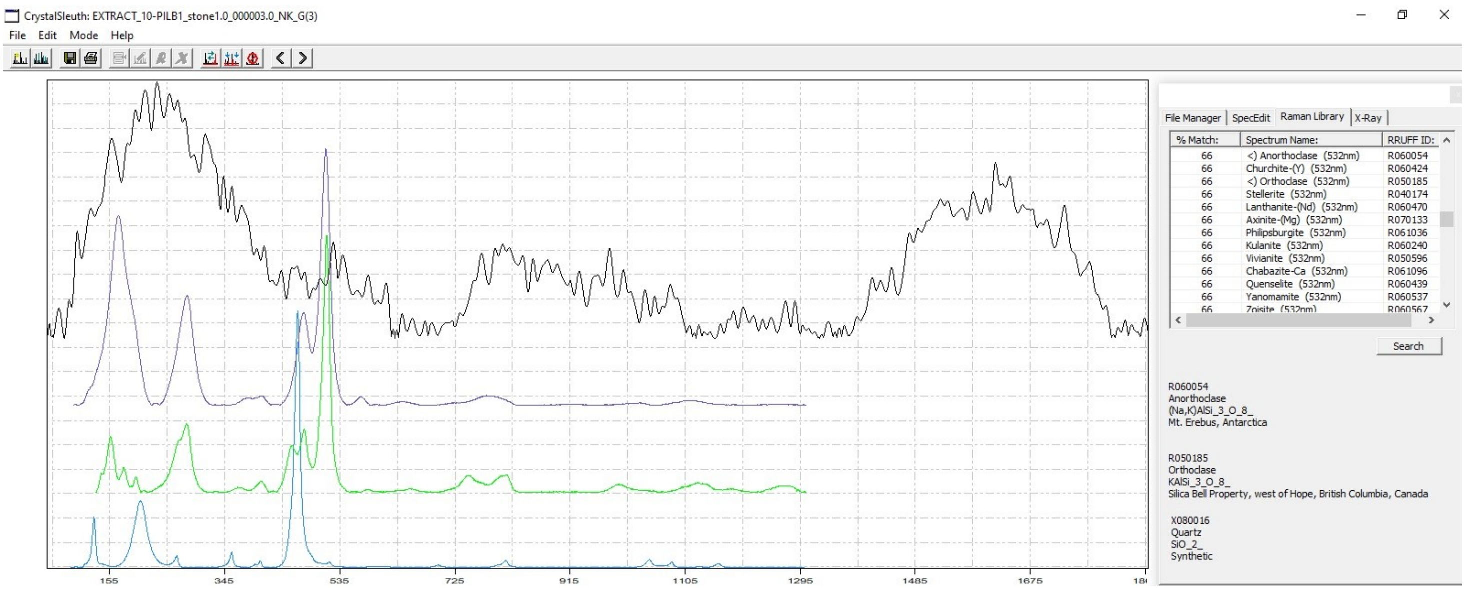
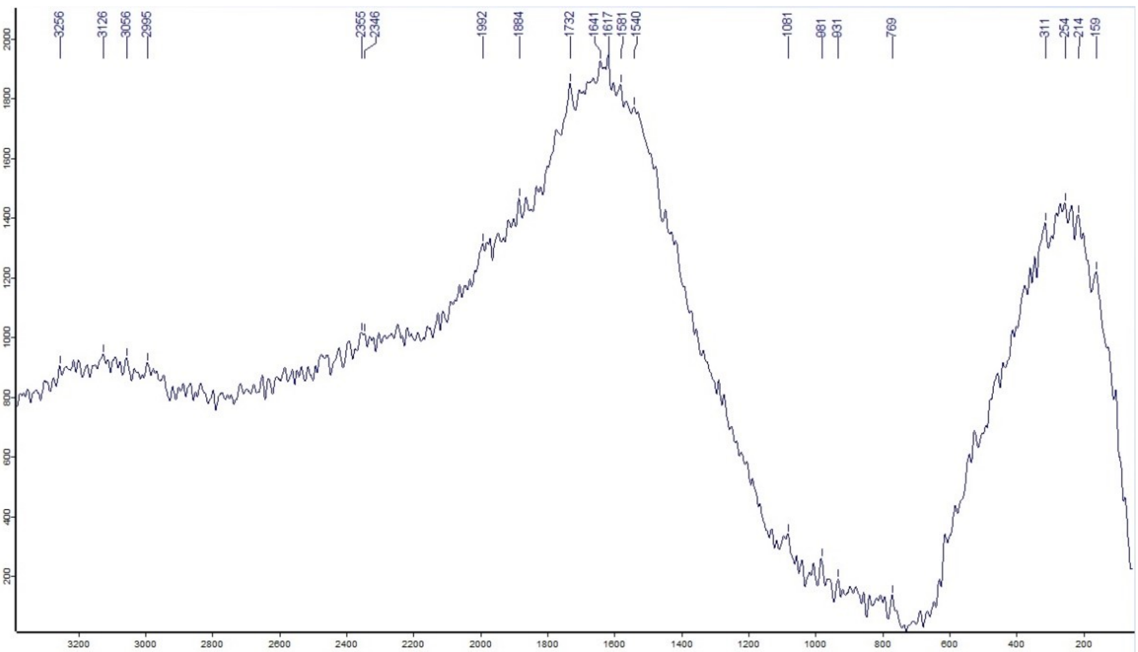
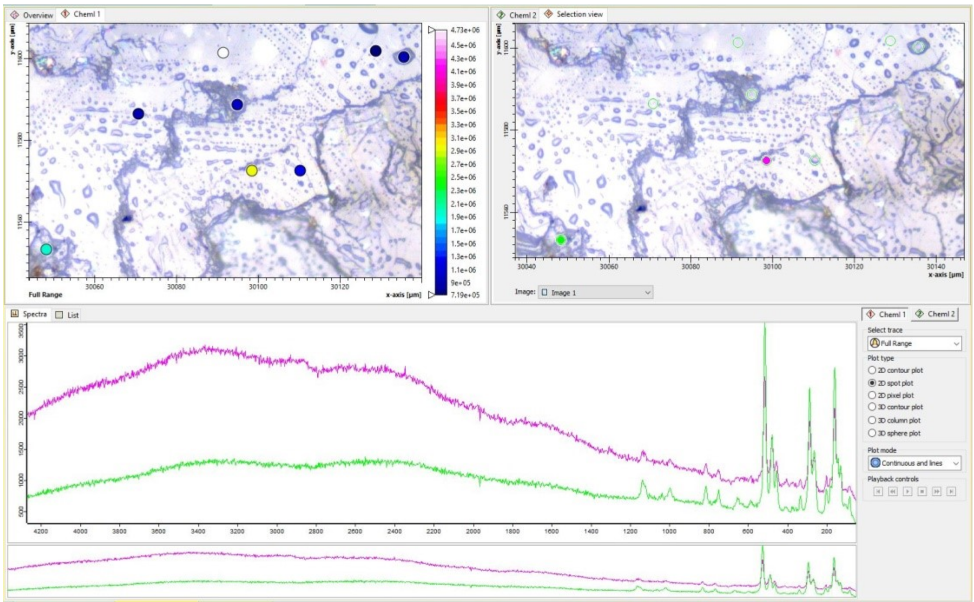




Sample Site 25 : Stone 3_spectra 1 indicates : Microcline , Orthoclase (→ see RRUFF_CS results)



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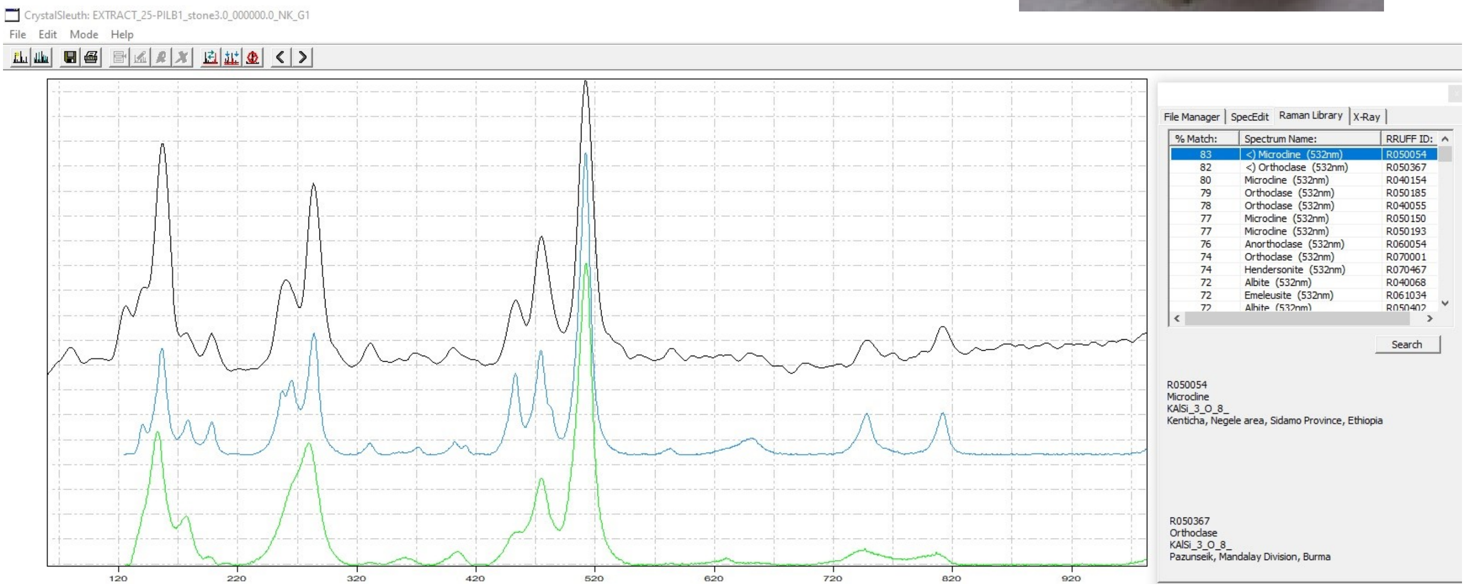
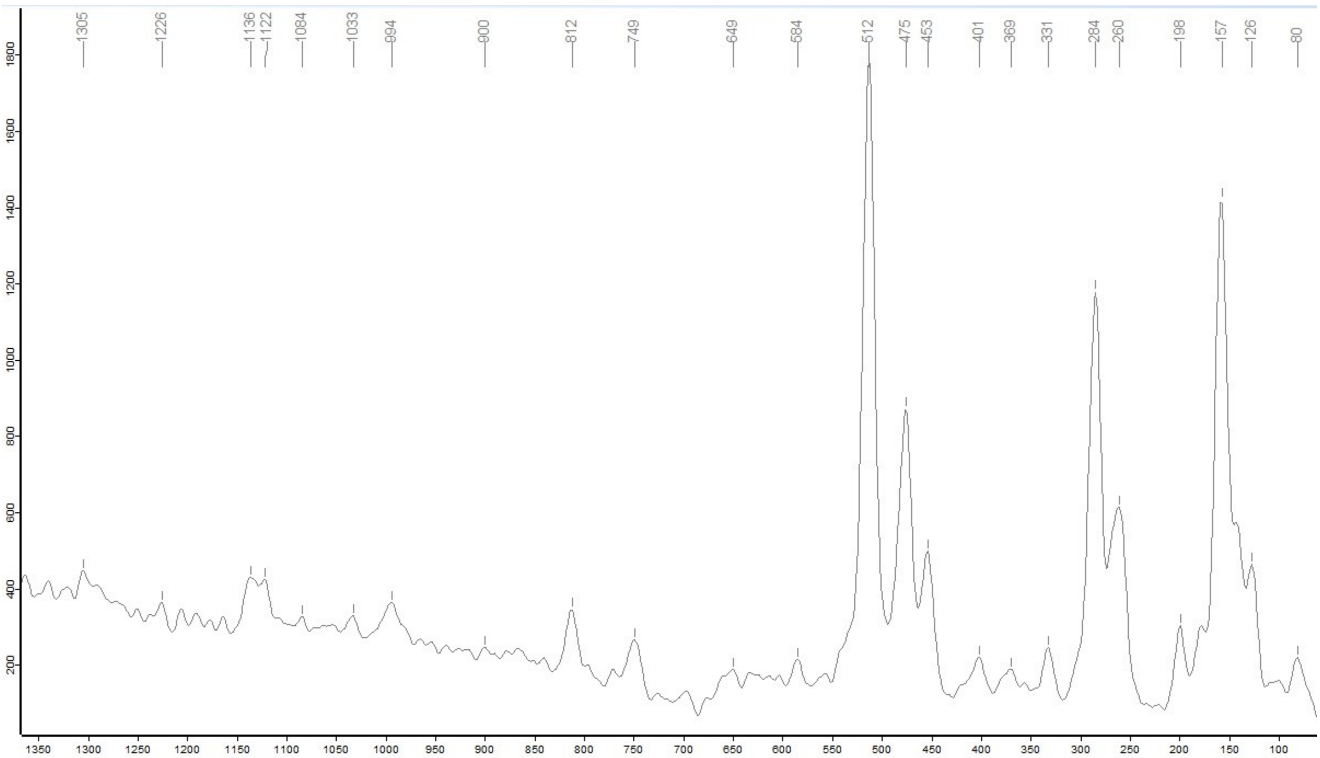
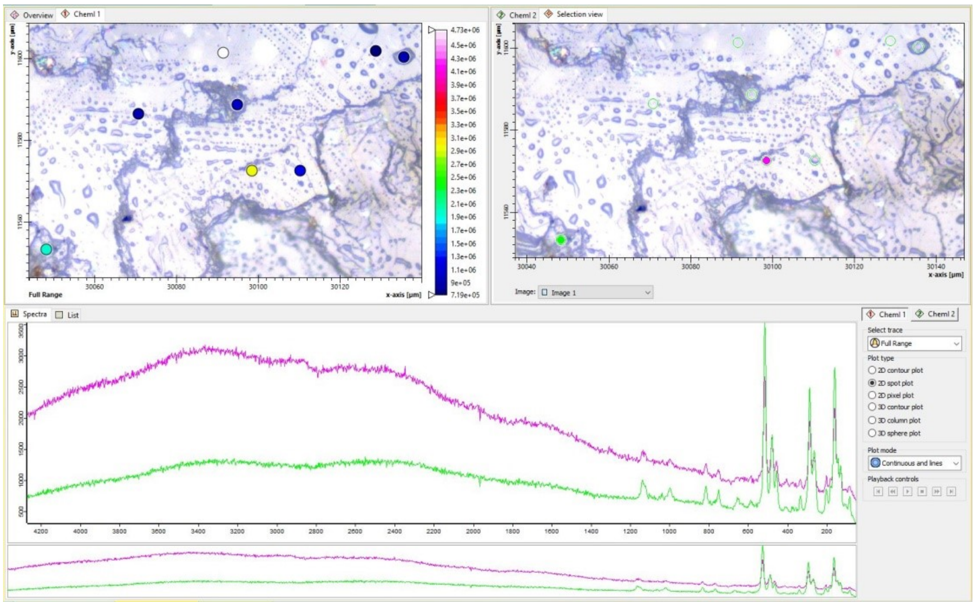
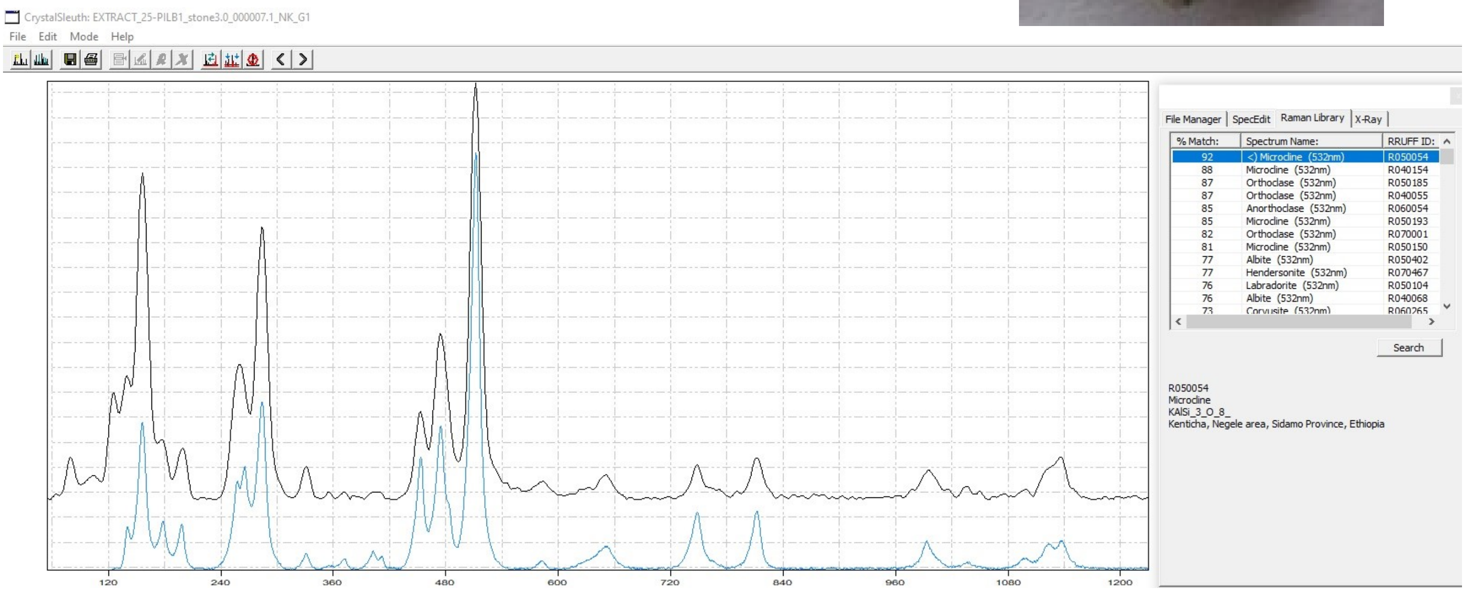


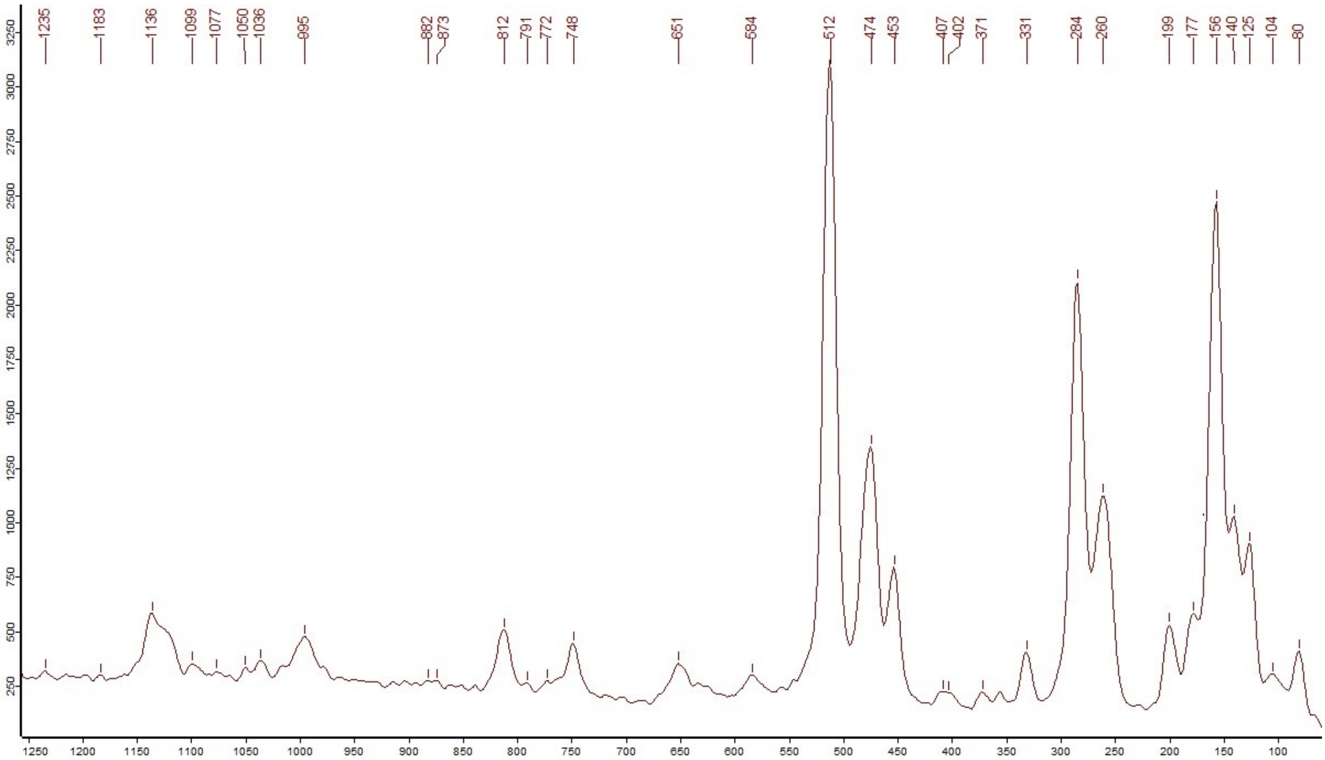


Sample Site 25 : Stone 3_spectra 3 indicates : Microcline (→ see RRUFF_CS results)

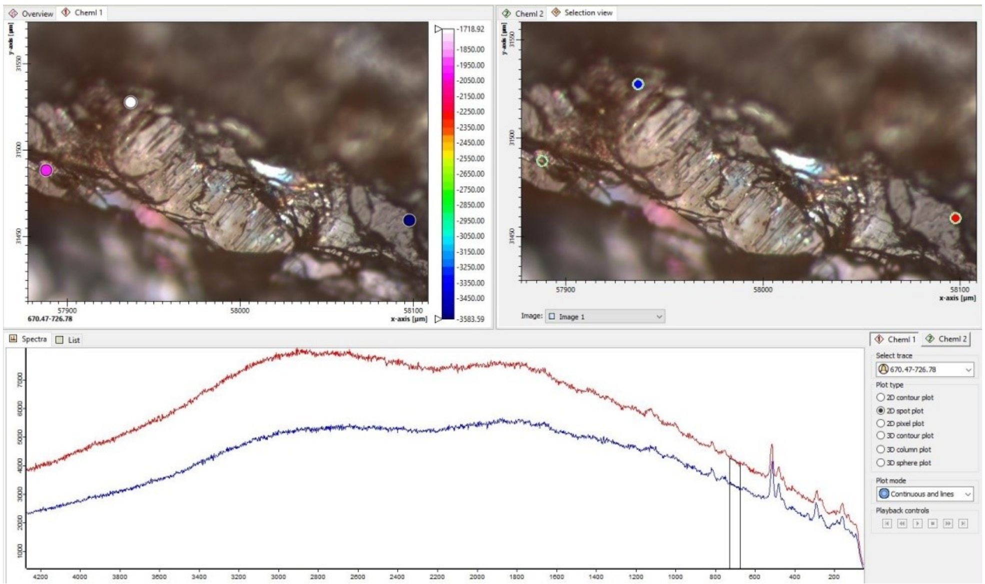


Sample :



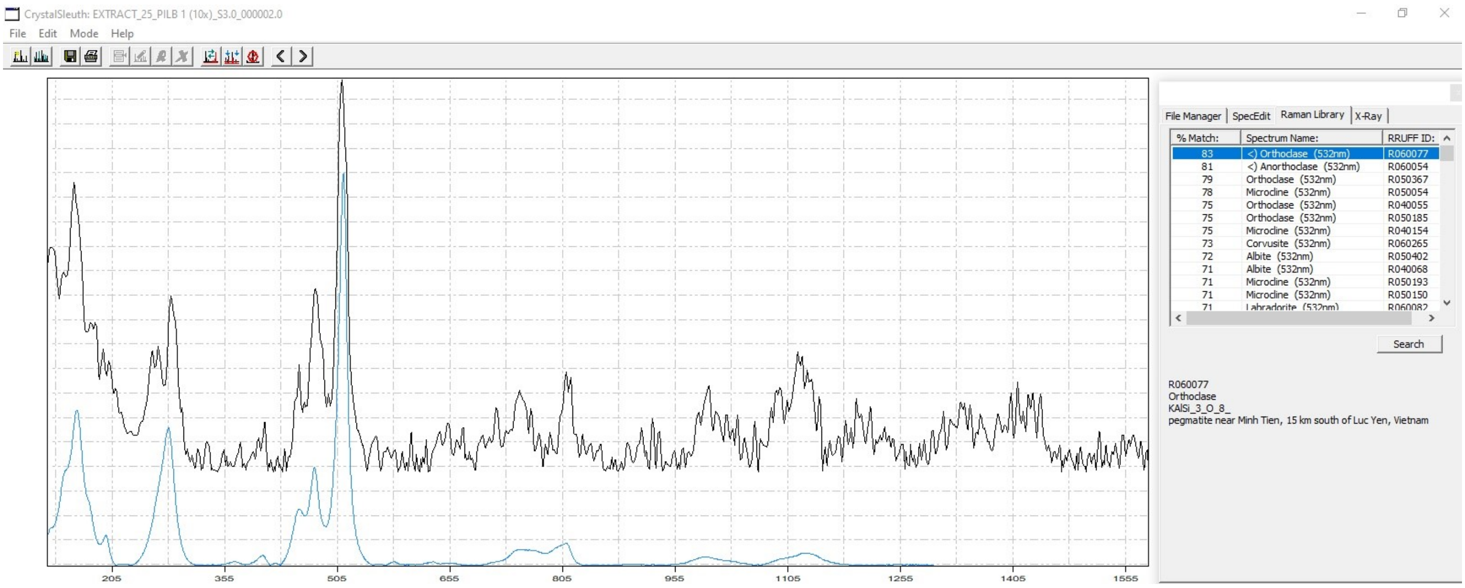


Sample Site 25 : Stone 3_spectra 4 indicates : Microcline, Orthoclase (→ see RRUFF_CS results)

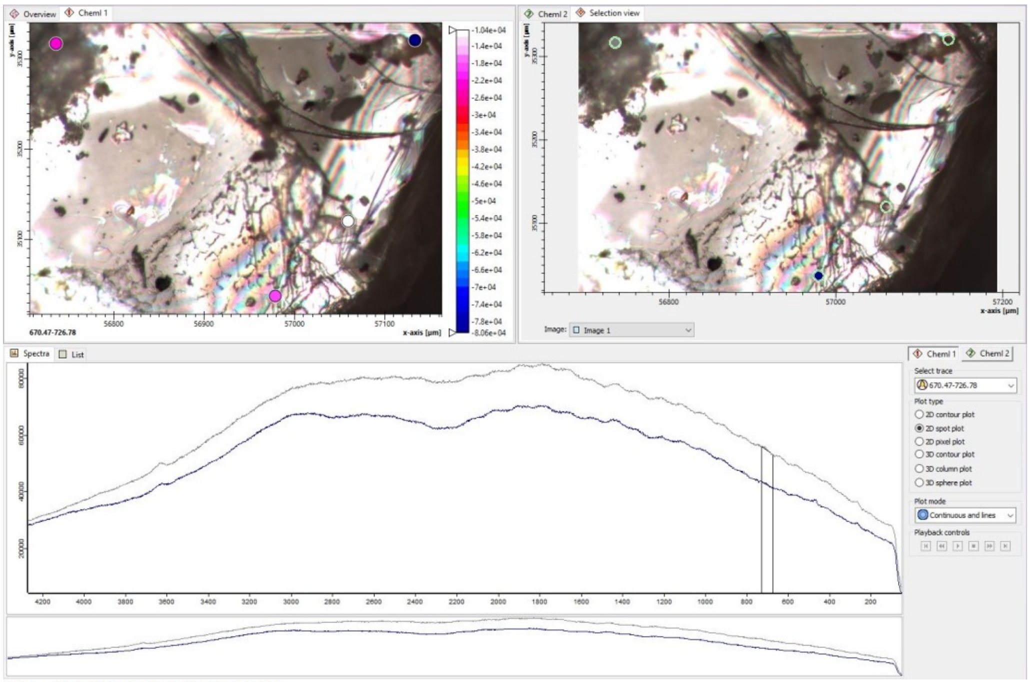


Possible PDFs (Planar Deformation Features) in the sample !

Sample :



Sample-Site 25 : Stone 2_spectra 3 indicates : Quartz (→ see RRUFF_CS results)



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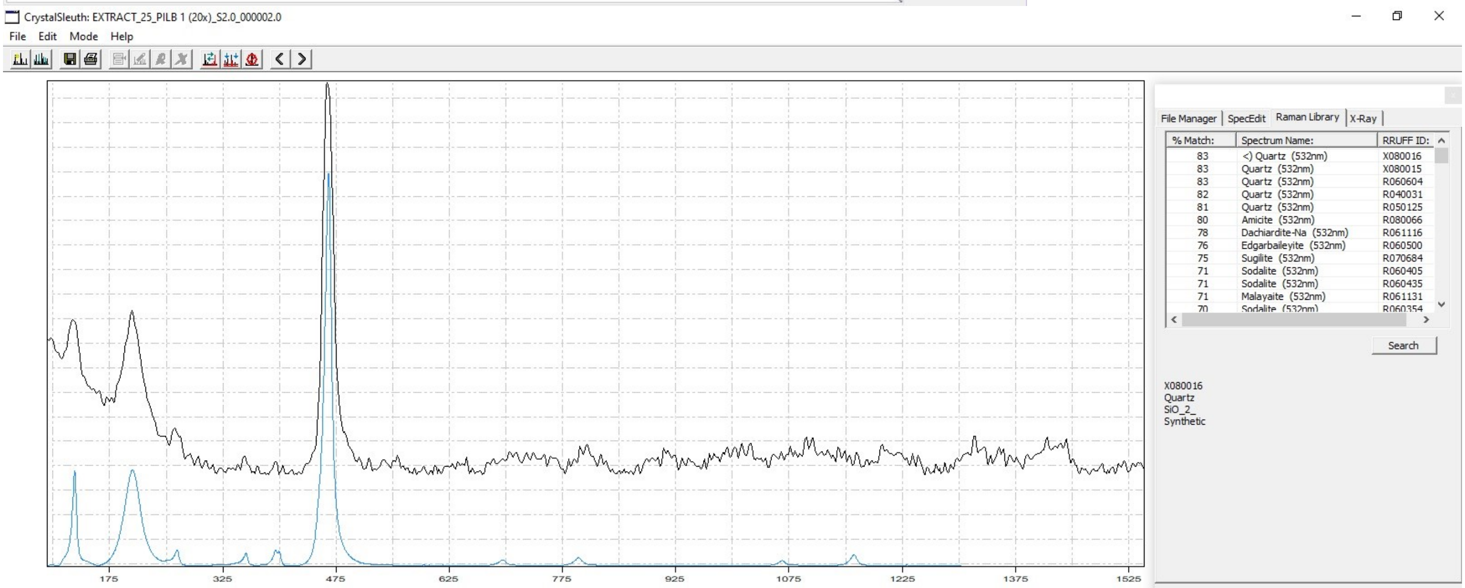
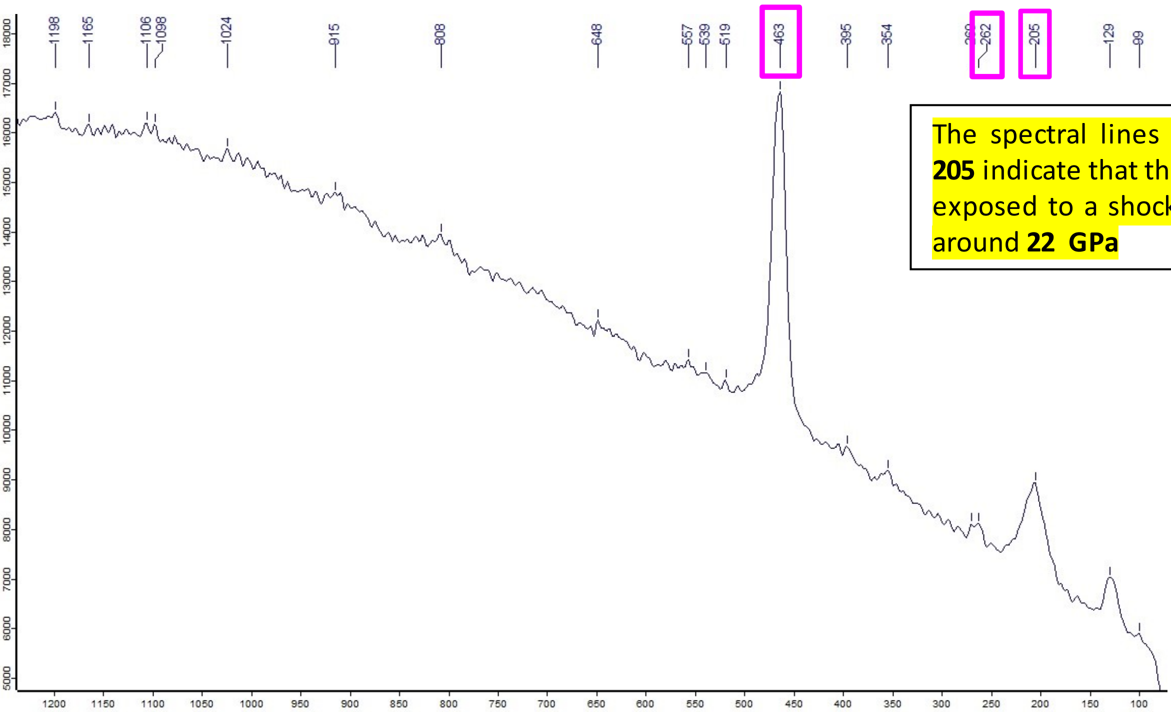


Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463, 262 and 205



The spectral lines **463, 262** and **205** indicate that the Quartz was exposed to a shock pressure of around **22 GPa**

Appendix 1 : **Photos of the rock samples from sample sites : 25, 10, 11 and 12-B**

Please note : **Photos of the Samples Sites 25, 10, 11 and 12-B and other sample sites are available on my website. → weblink : Sample Sites Pilbara Crater 1**

25

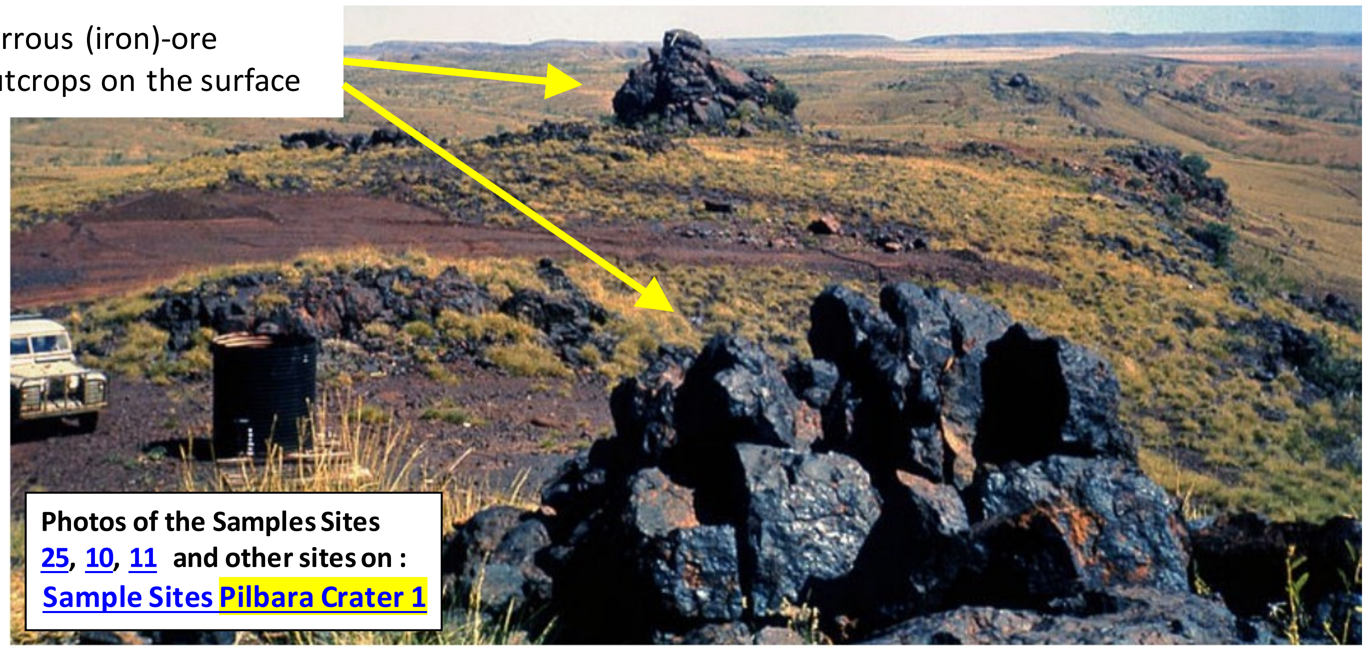
Note : Site 25 is accessible over an unsealed road. But it is located on a mine-site. Permission may be required !

Photos of the Samples Sites (alternative links)
25, 10, 11 and other sites on :
Sample Sites Pilbara Crater 1

10

Note : The Sites 10, 11, 12 and 25 are accessible over unsealed roads But they are located on mine-sites ! Permission may be required to do an expedition !

Area of the samples sites 10,11 & 12-B : Image of the secondary impact site as it was in the 1960's
Mt Goldsworthy had the world's richest deposits of ferrous ore. They were graded as high as **68 % !**



Photos of the Samples Sites
25, 10, 11 and other sites on :
Sample Sites Pilbara Crater 1

Appendix 2 : A short overview : The Raman bands (peaks) of Quartz shocked with 22-26 GPa

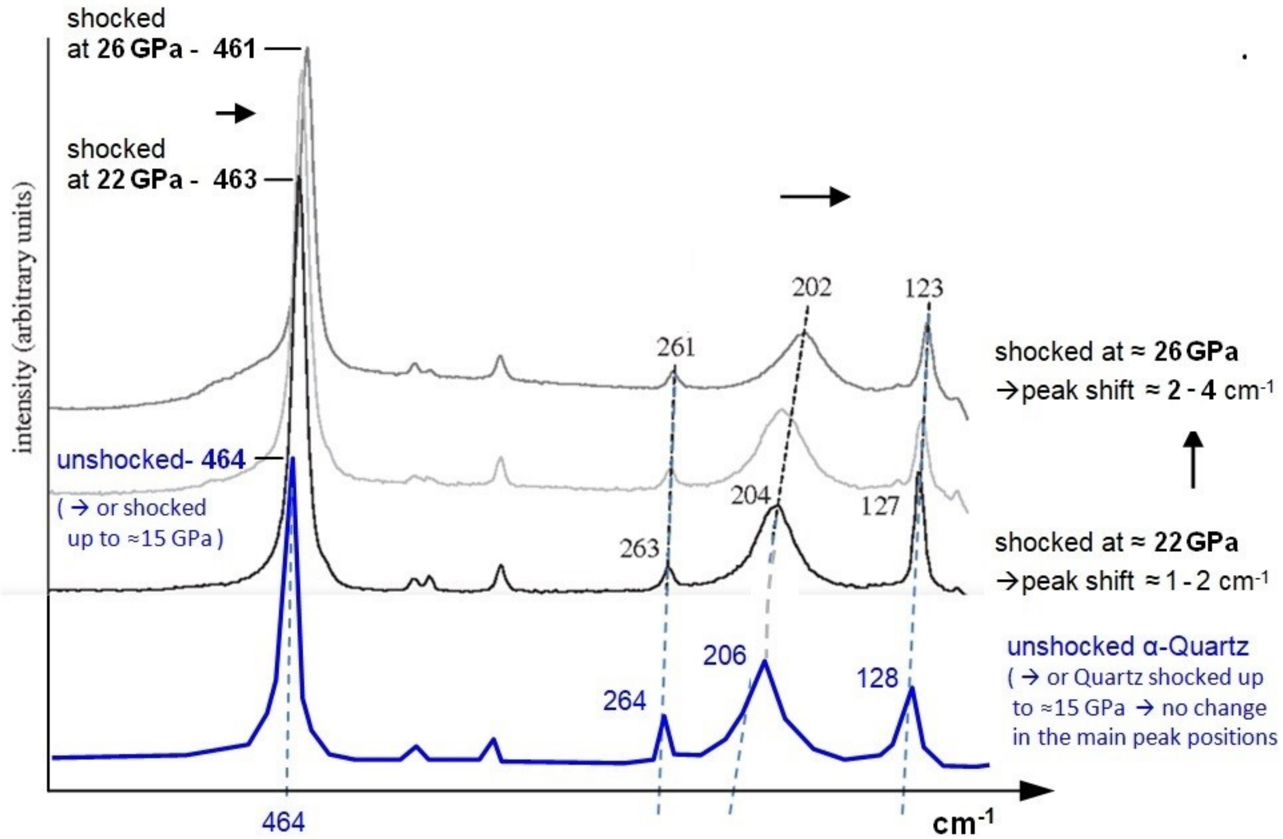
In order to verify a sample site as an impact site or impact structure, shock-metamorphic effects must be discovered in the rocks of the sample site. This can be done by different methods.

For example with the help of PDFs (planar deformation features) which are visible in the quartz with the help of a microscope. However this requires careful preparation of the samples and expertise.

Another, easier method, is the use of a RAMAN microscope. Micro-RAMAN Spectroscopy on quartz grains in the samples can provide the first evidence for a shock event, that was caused by an impact.

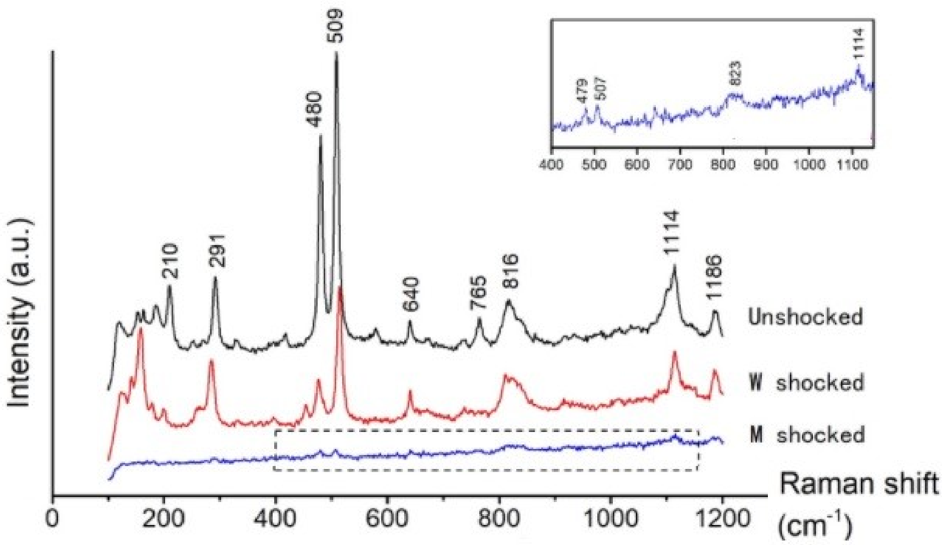
Mc Millan et al. (1992) and others have shown that the main RAMAN-peaks of Quartz shift towards lower frequencies if the Quartz was exposed the a shock-pressure > 15 GPa. → see diagram below

The shift of the main quartz RAMAN-peaks can be used to identify quartz that was shocked by an impact



Quartz shocked with **22 GPa** and **26 GPA** shows shifts of the main RAMAN-peaks of 1 - 4 cm^{-1} to lower frequencies

Appendix 3 : Raman spectra of (W) weakly-shocked & (M) moderately-shocked Alkali-Feldspar



Weakly shocked alkali feldspar mainly developed irregular fractures and undulatory extinction. Note that the Raman-lines 210 and 765 are missing in the w-shocked feldspar, and an additional line at ≈ 150 appears.

The shock pressure for the w-shocked feldspar was estimated to be between 5 and 14 GPa

References :

Photos of all Sample Sites & Rock Samples are available on : Sample Sites Pilbara Crater 1 (or : Sites Pilbara Crater 1)

A Complex 30 km Secondary Impact Crater in the Pilbara Region in West-Australia - by Harry K. Hahn
https://vixra.org/abs/2101.0152
or alternative : https://archive.org/details/a-complex-30-km-secondary-impact-crater-in-the-pilbara-region-in-west-australia

The Permian-Triassic (PT) Impact hypothesis - by Harry K. Hahn - 8. July 2017 :
Part 1 : The 1270 X 950 km Permian-Triassic Impact Crater caused Earth's Plate Tectonics of the Last 250 Ma
Part 2 : The Permian-Triassic Impact Event caused Secondary-Craters and Impact Structures in Europe, Africa & Australia
Part 3 : The PT-Impact Event caused Secondary-Craters and Impact Structures in India, South-America & Australia
Part 4 : The PT-Impact Event and its Importance for the World Economy and for the Exploration - and Mining-Industry
Part 5 : Global Impact Events are the cause for Plate Tectonics and the formation of Continents and Oceans (Part 5)
Part 6 : Mineralogical - and Geological Evidence for the Permian-Triassic Impact Event
Alternative weblinks for my Study **Parts 1 - 6 with slightly higher resolution** : Part 1, Part 2, Part 3, Part 4, Part 5, Part 6
Parts 1 – 6 of my PTI-hypothesis are also available on my website : **www.permiantriassic.de** or **www.permiantriassic.at**

Shock-metamorphic effects in rocks and minerals - https://www.lpi.usra.edu/publications/books/CB-954/chapter4.pdf

Shock metamorphism of planetary silicate rocks and sediments: Proposal for an updated classification system
Stöffler - 2018 - Meteoritics & Planetary Science – Wiley: https://onlinelibrary.wiley.com/doi/epdf/10.1111/maps.12912

A Raman spectroscopic study of shocked single crystalline quartz - by P. McMillan, G. Wolf, Phillipe Lambert, 1992
https://asu.pure.elsevier.com/en/publications/a-raman-spectroscopic-study-of-shocked-single-crystalline-quartz
alternative : https://www.semanticscholar.org/paper/A-Raman-spectroscopic-study-of-shocked-single-McMillan-Wolf/cfaaf6eb3e46fbd2912fb91c7acf40e88e721132

Raman spectroscopy of natural silica in Chicxulub impactite, Mexico - by M. Ostroumov, E. Faulques, E. Lounejeva
https://www.academia.edu/8003100/Raman_spectroscopy_of_natural_silica_in_Chicxulub_impactite_Mexico
alternative : https://www.sciencedirect.com/science/article/pii/S1631071302017005

Shock-induced irreversible transition from α-quartz to CaCl2-like silica - Journal of Applied Physics: Vol 96, No 8
https://aip.scitation.org/doi/10.1063/1.1783609

Shock experiments on quartz targets pre-cooled to 77 K - J. Fritz, K. Wünnemann, W. U. Reimold, C. Meyer
https://www.researchgate.net/publication/234026075_Shock_experiments_on_quartz_targets_pre-cooled_to_77_K

A Raman spectroscopic study of a fulgurite – by E. A. Carter, M.D. Hargreaves, …
https://www.researchgate.net/publication/44655699_Raman_Spectroscopic_Study_of_a_Fulgurite
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