

# The Ø 50 km Archean ( >3 Gyr ) Impact Structure ( NW-Australia / Pilbara )

- Raman Spectra of selected Rock Samples - by Harry K. Hahn, 30.12.2021 -

## Summary :

The ≈ Ø 50 km Archean Impact Structure with an age of > 3 Gyr is located ≈150 km SE of Port Headland on the Pilbara Craton near Marble Bar / Western Australia. The impact structure is noticeable on a magnetic anomaly map and on a contrast-enhanced satellite map. It is a yet unknown impact structure !

This impact crater is very interesting, especially for Astrobiologists, because some of the earliest life-forms on Earth developed inside the crater-area after the impact ! The Dresser- and Strelley-Pool Formations inside the crater contain some of the oldest fossilized Stromatolites on Earth !

Please read my more detailed study about this Impact Crater here :

[The 50 km Archean Impact Crater \( Age >3 Ga \) in the Pilbara Craton \( Australia \)](#) – ( alternative : [Link 2](#) )

I have analysed some rock samples which I have collected along a main-road which passes the crater just outside its northern crater-rim-area ( samples No: 14 to 21 ). Note that the original crater-wall was later deformed by an (expansion) tectonic process that obviously was caused by the impact. And the impact in all probability was an oblique impact, which means the impactor impacted in a relatively shallow angle of  $\leq 30^\circ$ . Because of the oblique impact and the tectonic-process, fragments of the original crater-wall ended up further north close to the road where I collected the samples. Therefore there is a good chance that the collected samples originate from the elevated crater-rim area.

**The Raman spectra of quartz from the sample sites 14, 16, 18 and 21-A collected along the main-road provide first evidence for an impact ( shock ) event as the probable cause of the described structure.**

**The shifts of the main Raman peaks, of analysed quartz grains from these sites, to the lower frequencies 463, 259/266, 125  $\text{cm}^{-1}$  and 463, 262, 125 and 463, 263, 204 and 463, 263, 126 are a clear first indication for an impact shock event that has caused a shock pressure of around 22 GPa !**

**Further indication comes from the Raman-spectrum of quartz from sample site 23 collected near the small town Marble Bar, that originates from the western crater-rim-area of the impact crater, which also shows clear shifts of the main Raman peaks to the lower frequencies : 463, 262, 204 and 125  $\text{cm}^{-1}$**

(→ see explanation in **Appendix 1** at page **24** : Overview : The Raman bands (peaks) of shocked Quartz)

Microscopic images of some of the analysed quartz grains may provide further proof for a shock event. ( → see microscopic-Images on the **pages : 6, 7, 9, 10, 11 and 13** ).

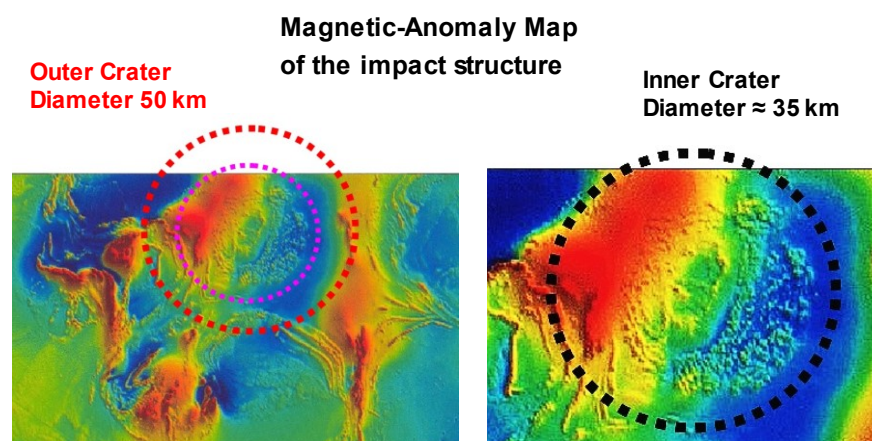
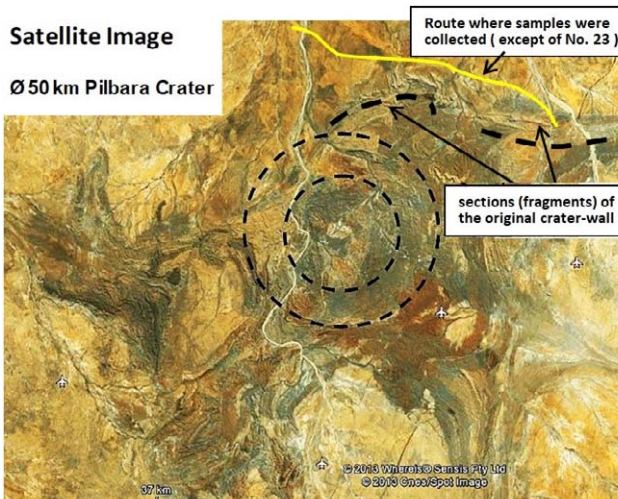
All spectra were made with a **BRUKER Senterra-II Raman Microscope** ( wavenumber precision  $<0.1\text{cm}^{-1}$  )

→ Images of the analysed rock samples and photos of the sample sites are in the Appendix at **page 18**.

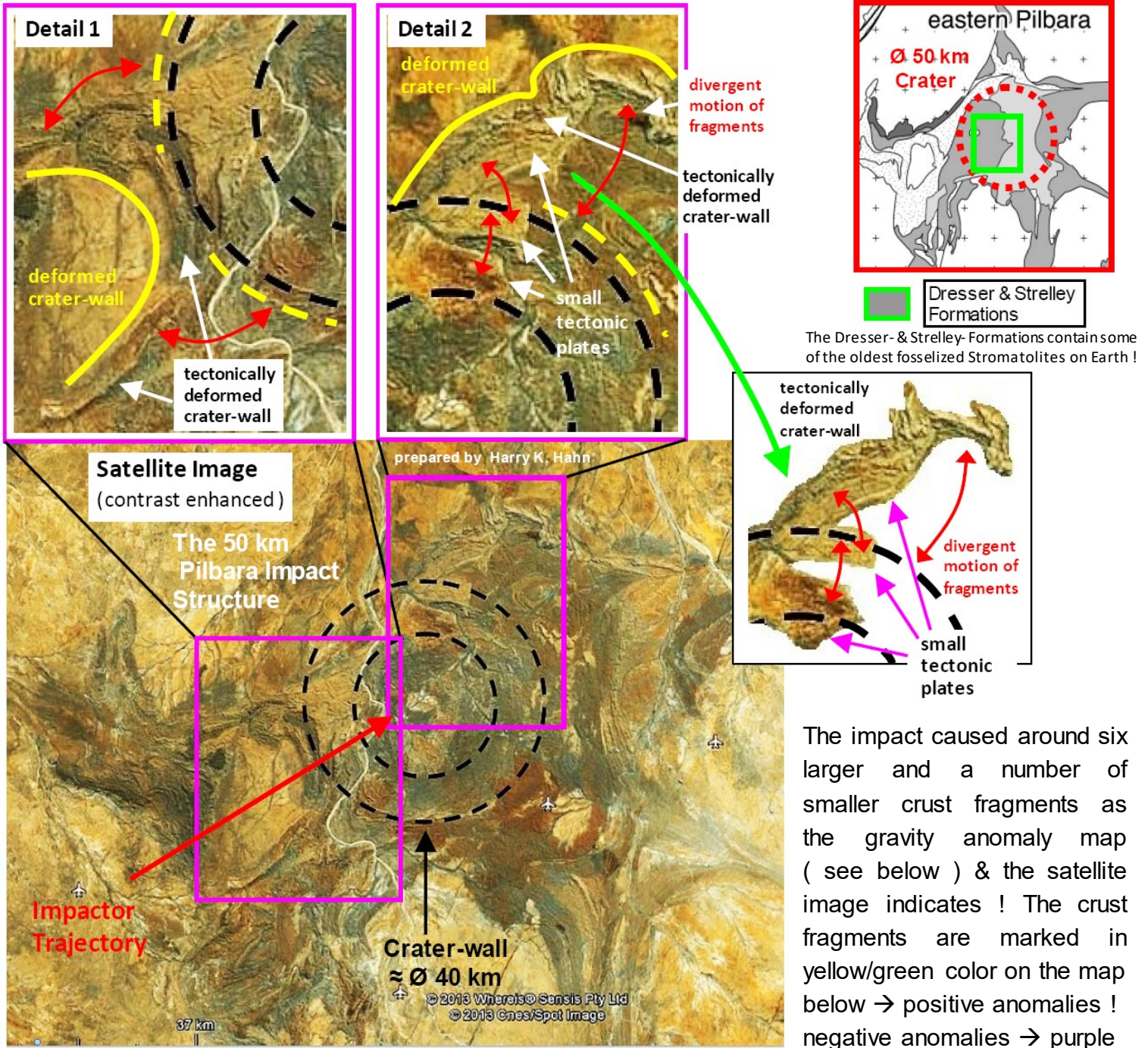
→ More images of all sample sites are available on [www.permiantriassic.de](http://www.permiantriassic.de) or [www.permiantriassic.at](http://www.permiantriassic.at)

→ **References** to interesting studies regarding the described impact-crater area : see **page 25**

**Note:** A shock pressure of 20 GPa exceeds every pressure caused by normal terrestrial metamorphism. The indicated shock pressure of ≈ 20 GPa is lower than the shock pressure that occurred in other large impact craters on Earth. This indicates that the “**Pilbara Crater**” was caused by an oblique impact and that the impactor impacted at a relatively shallow angle with relatively low velocity of probably  $<10\text{ km/s}$ .



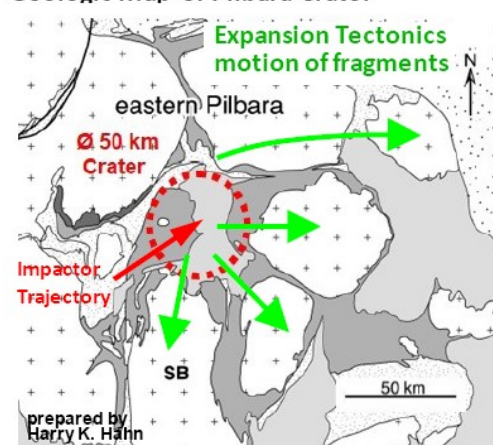
This yet unknown impact crater (impact structure) is very interesting, especially for Astrobiologists, because some of the earliest life-forms on Earth developed inside the crater area after the impact ! This area ( the impact structure ! ) probably is connected to the Barberton Greenstone Belt (BGB) Impact Event which happened 3.26 - 3.24 Ga ago in South-Africa ! , as the Geologist Andrew Y. Glikson pointed out. The Dresser- and Strelley-Pool Formations inside the crater contain some of the oldest fossilized Stromatolites on Earth ! There is a good chance that the impactor, possibly a carbon-rich (interstellar?) comet, has brought-in bacterial life-forms from outer space to Earth !



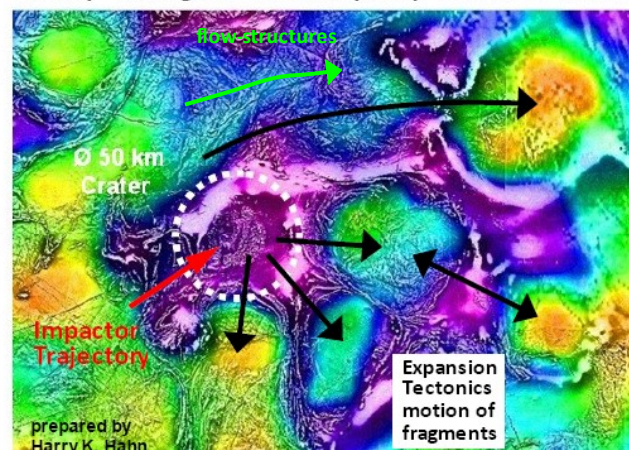
The impact caused around six larger and a number of smaller crust fragments as the gravity anomaly map ( see below ) & the satellite image indicates ! The crust fragments are marked in yellow/green color on the map below → positive anomalies !  
negative anomalies → purple

Because Earth's crust was still very thin at the time of the impact >3 billion years ago, the impactor probably was releasing most of its energy below the thin (≈1 to 3 km thin ) crust Therefore bacteria from the comet could have survived this impact !!!

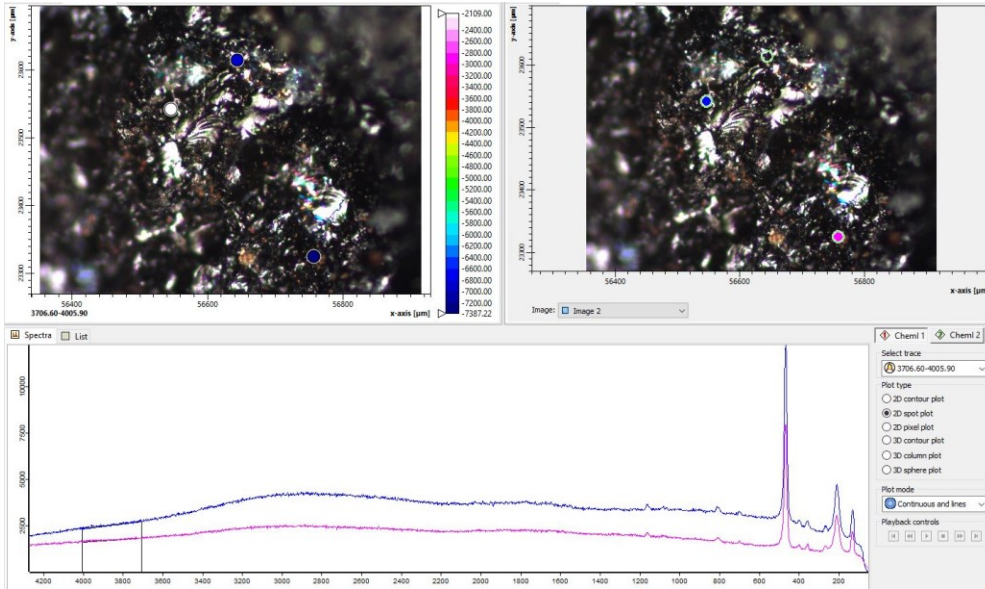
Geologic Map of Pilbara Crater



Gravity- & Magnetic-Anomaly Map of Pilbara Crater



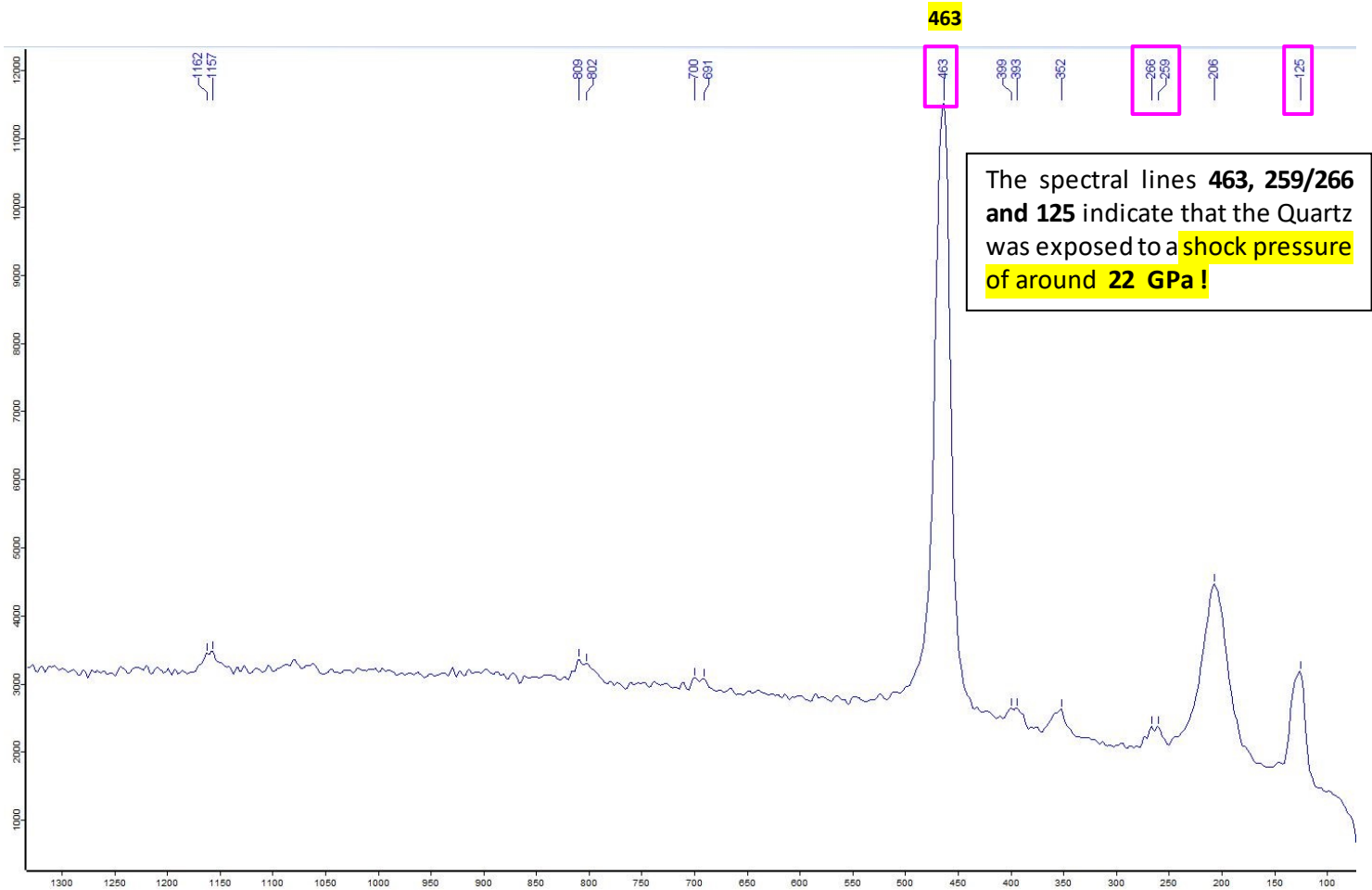
Sample Site 14 : Stone 1\_spectra 1 indicates : Quartz



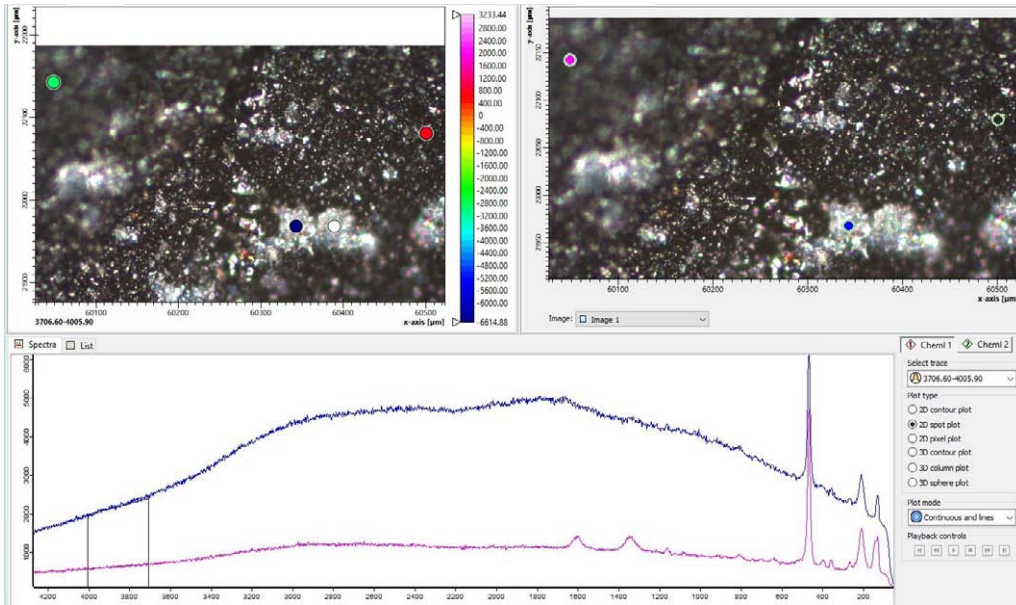
Sample :



Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463, 259/266 and 125



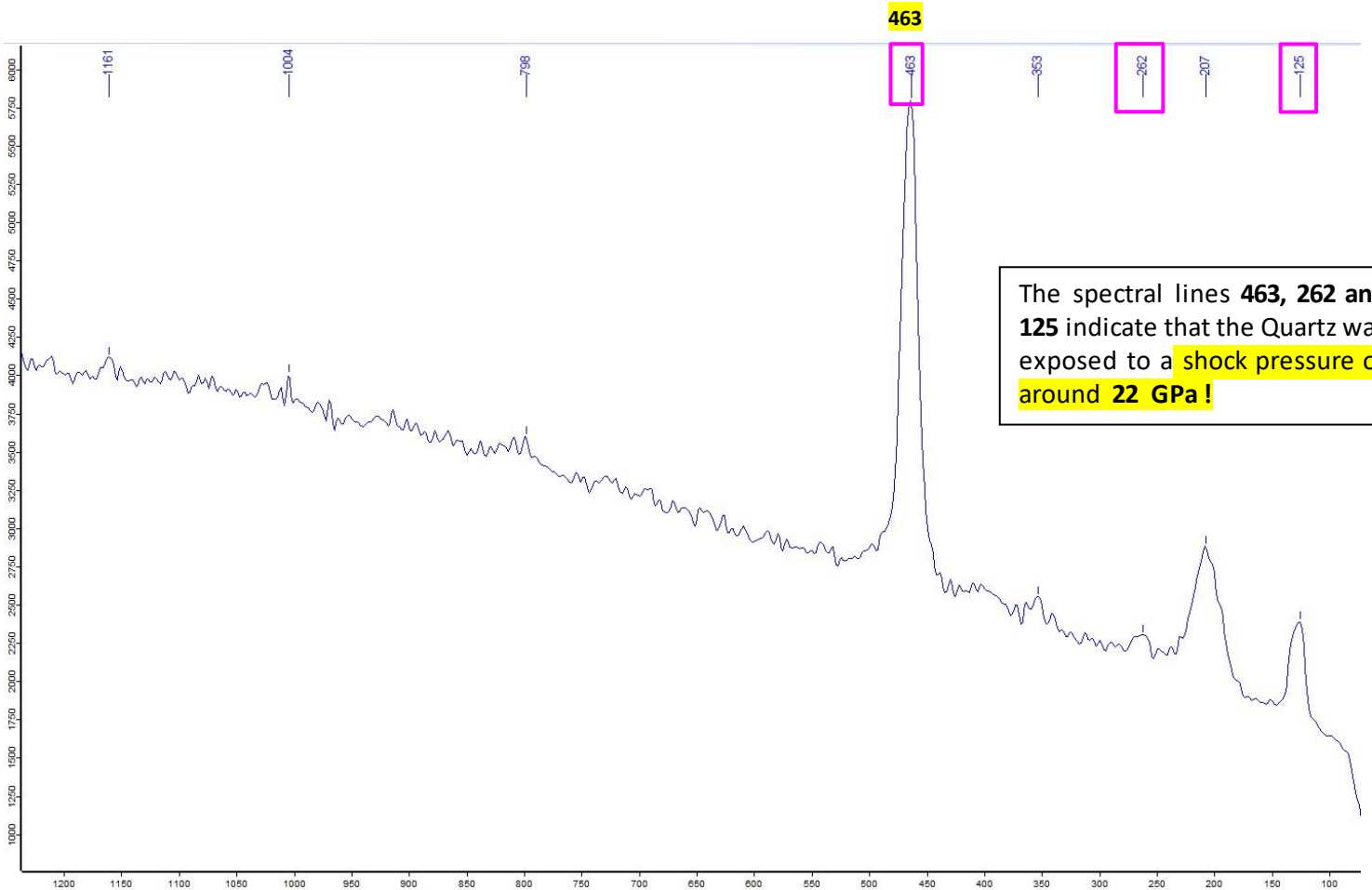
Sample Site **16**: Stone\_1\_spectra-1\_(blue) indicates: **Quartz**



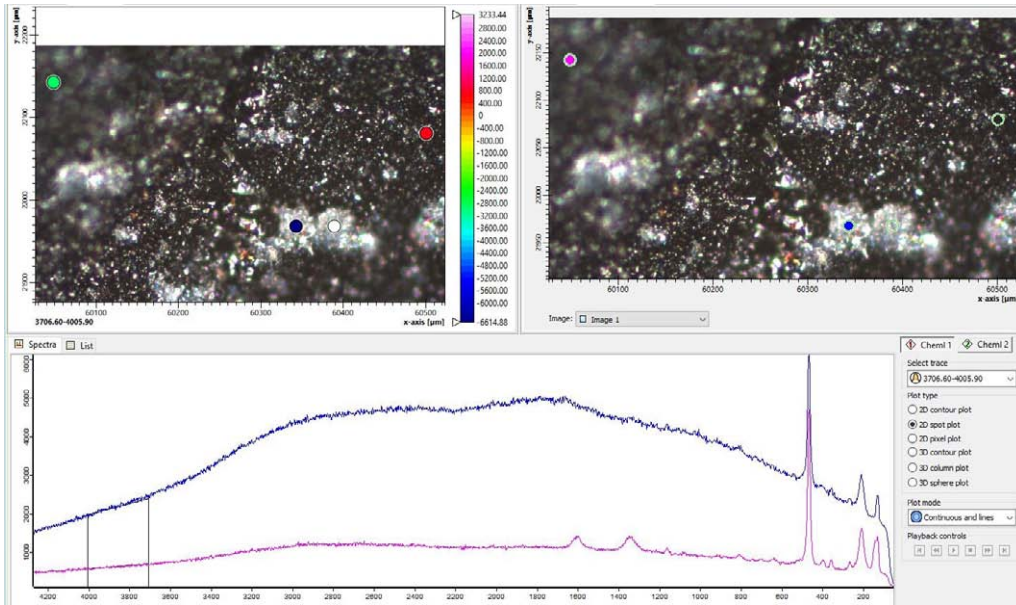
Sample :



Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463, 262 and 125



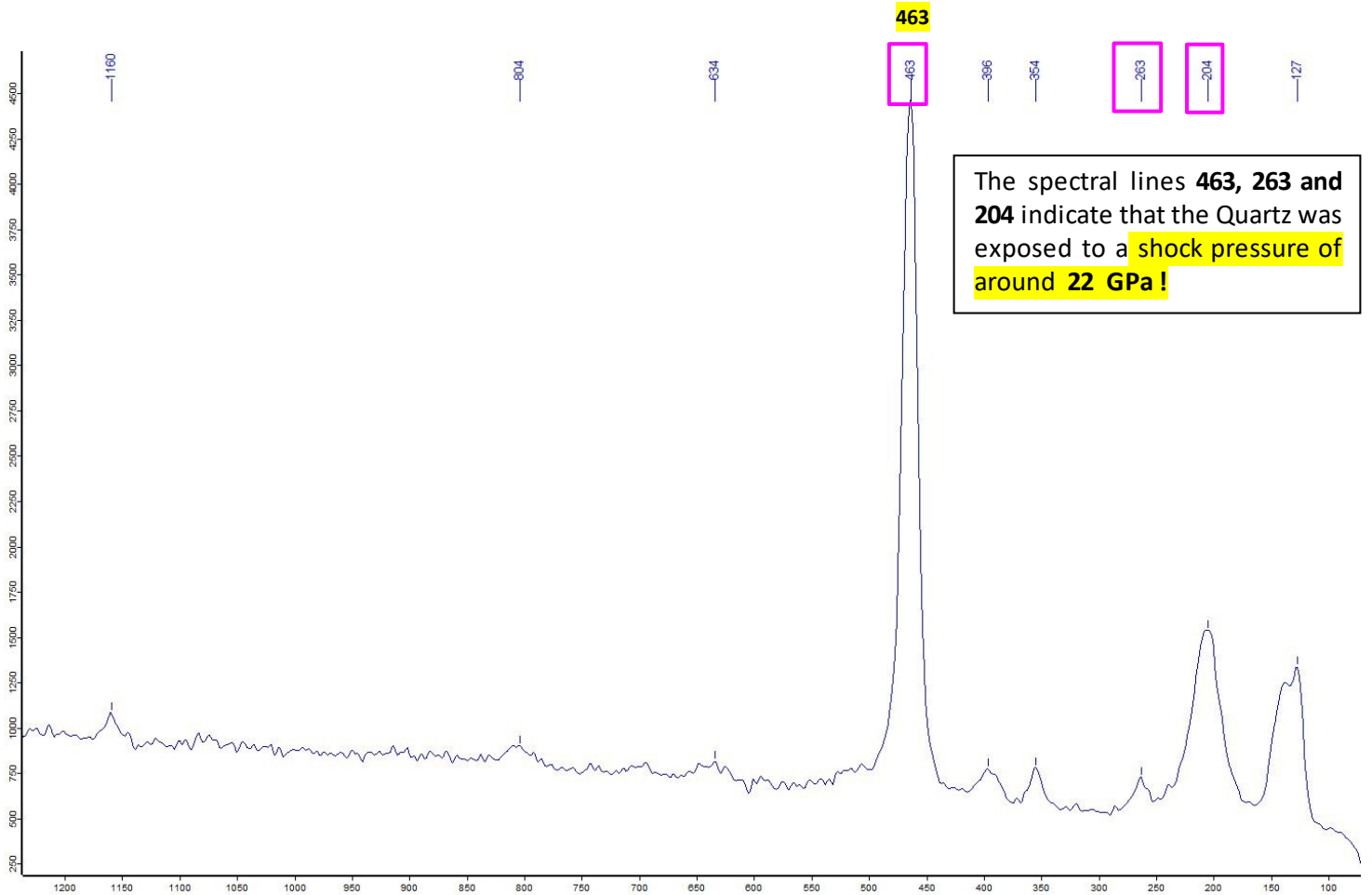
Sample Site 16: Stone 1\_spectra-2\_(pink) indicates: Quartz



Sample :

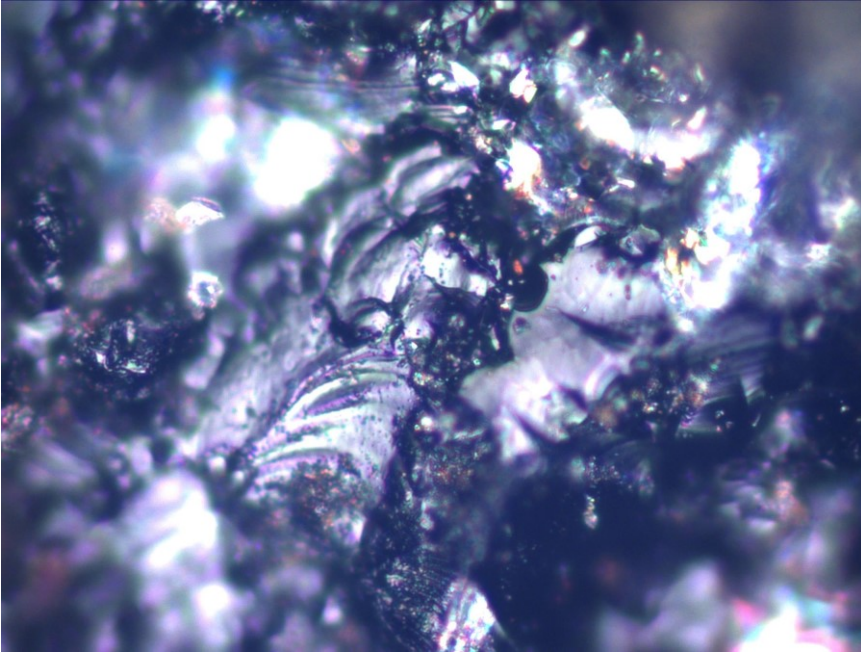


Indication for a shock event are the shifts of the marked Quartz spectral lines towards 463, 263 and 204

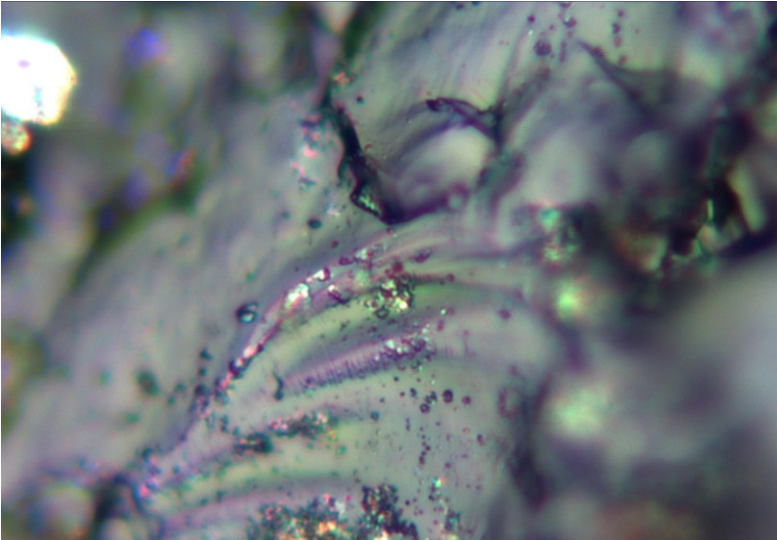


Microscopic Images : Sample from Site 14 and 16 → original state ( no preparation for analysis )

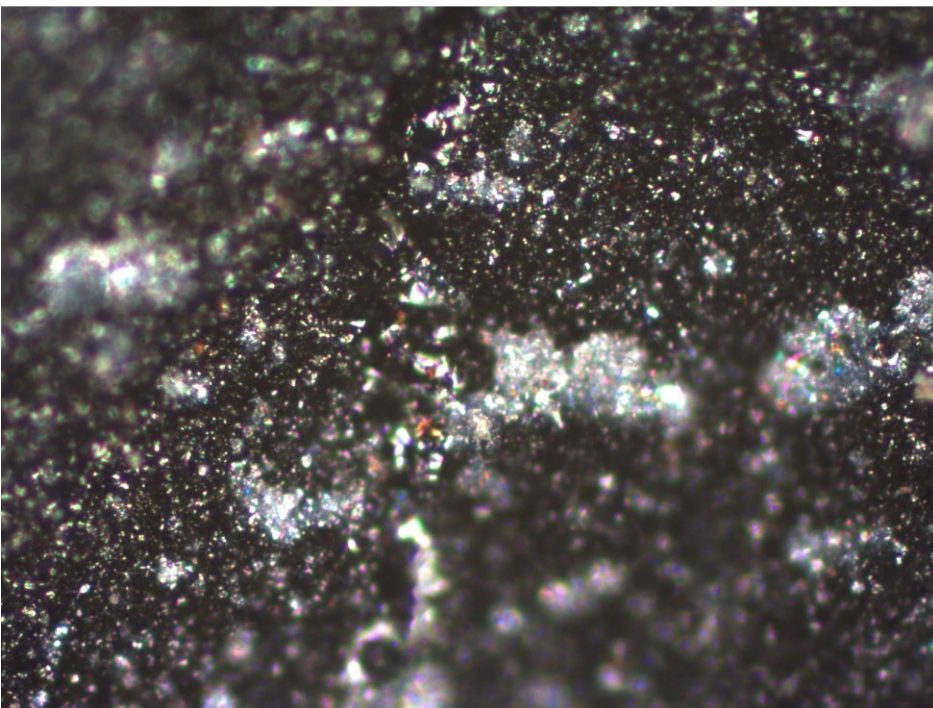
Sample Site **14** : Stone 1 : **Quartz** ( Image ~ 280 x 220  $\mu\text{m}$  )



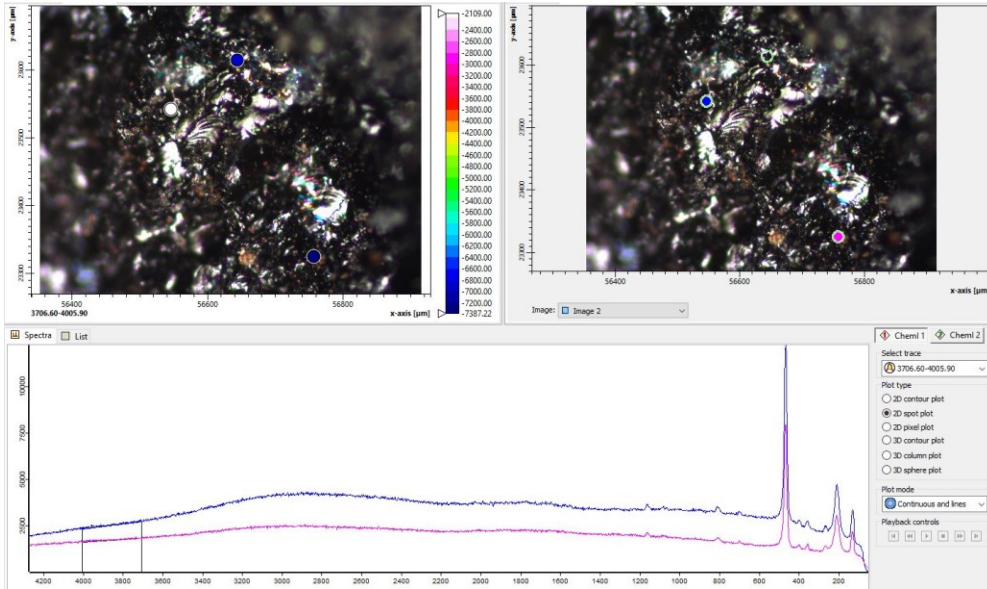
Sample Site **14** : Stone 1 : **Quartz** - Detail of above image ( Image size : ~ 100 x 70  $\mu\text{m}$  )



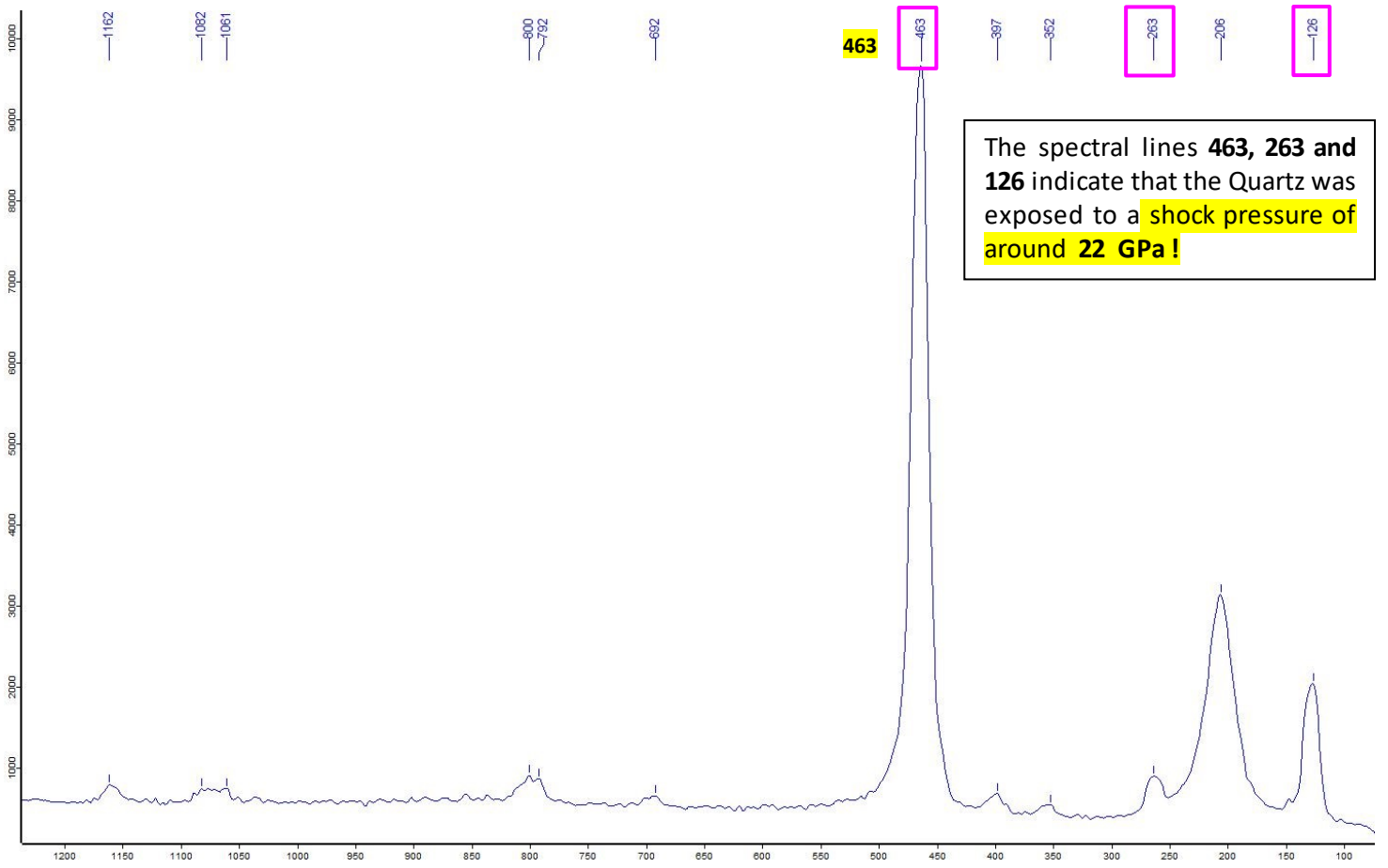
Sample Site **16** : Stone 1 : **Quartz** - Image size : ~ 500 x 400  $\mu\text{m}$



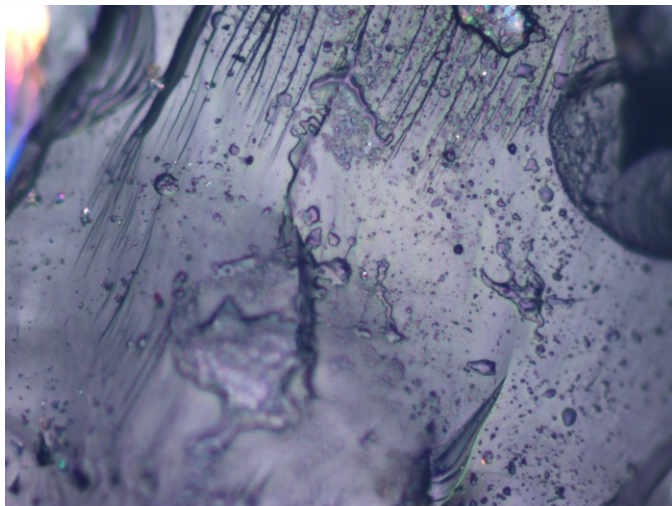
Sample Site 18: Stone 1\_spectra 1 indicates: Quartz



Sample :



The spectral lines 463, 263 and 126 indicate that the Quartz was exposed to a shock pressure of around 22 GPa !



Sample Site 18: Stone 1 : Quartz

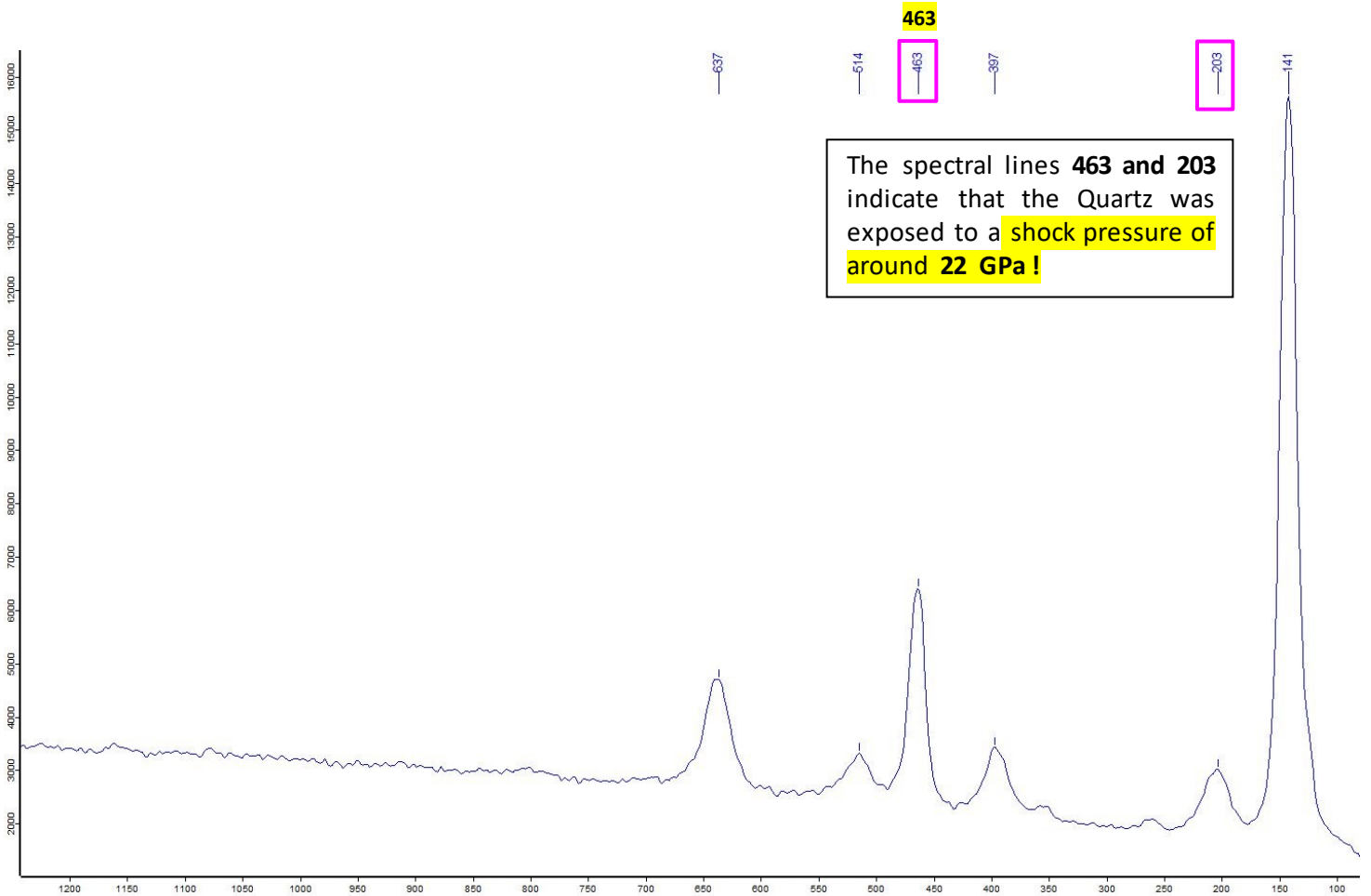
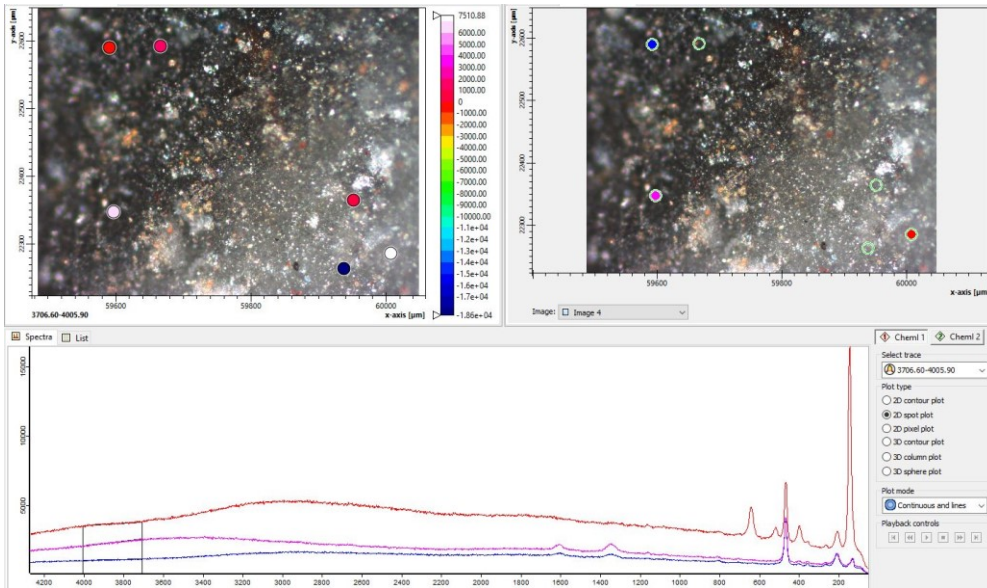
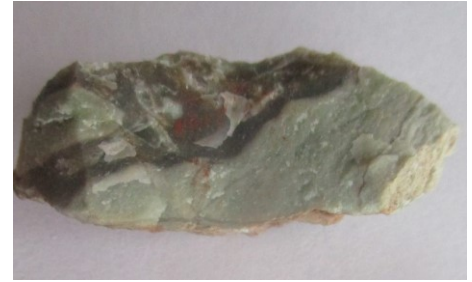
Detail of Microscopic Image

Image size : ~ 300 x 200 μm

Sample Site **21-A** : Stone 1\_spectra 1 indicates : **Quartz**

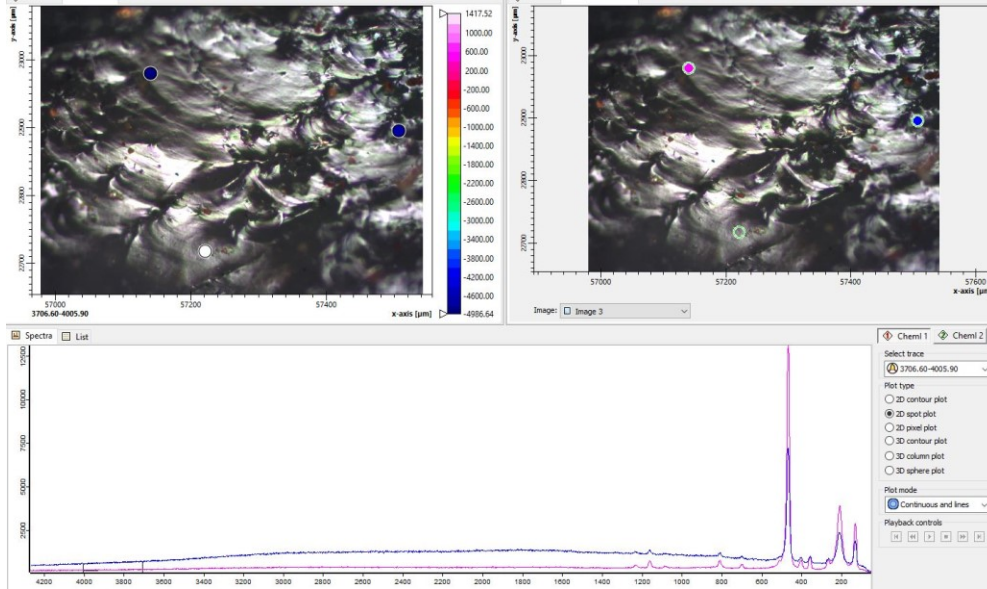
Beside Quartz, there are other minerals present in the sample. e.g. feldspar (spectral line 514)

Sample :

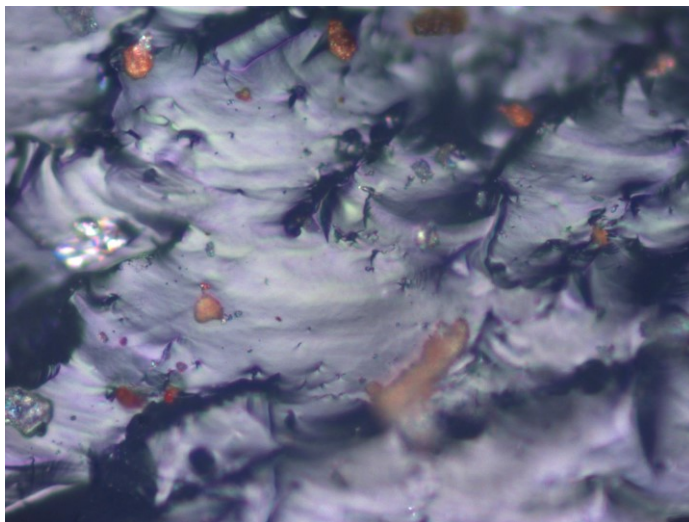
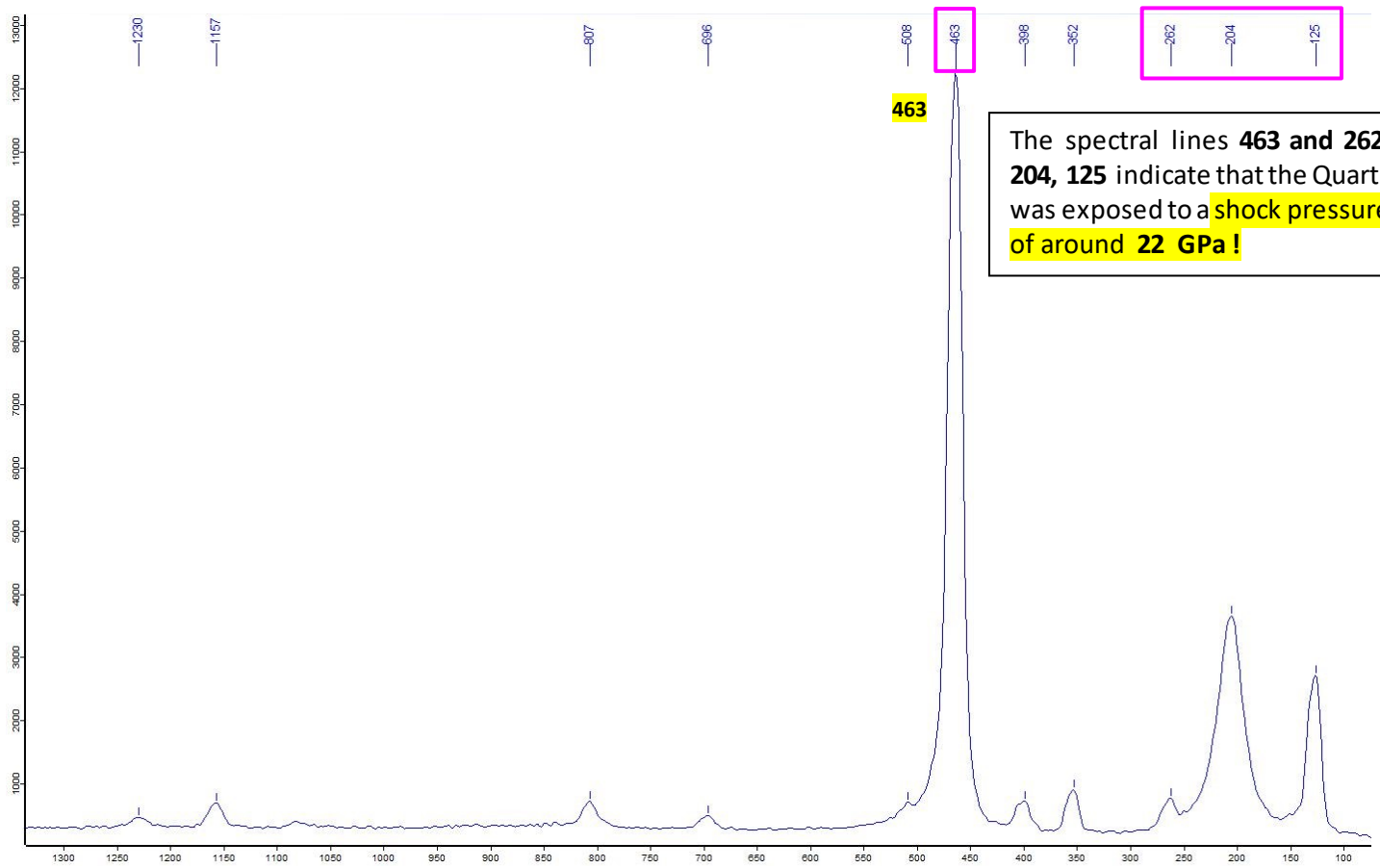




Sample Site **23** : Stone 1\_spectra 1 indicates : **Quartz**



Sample :



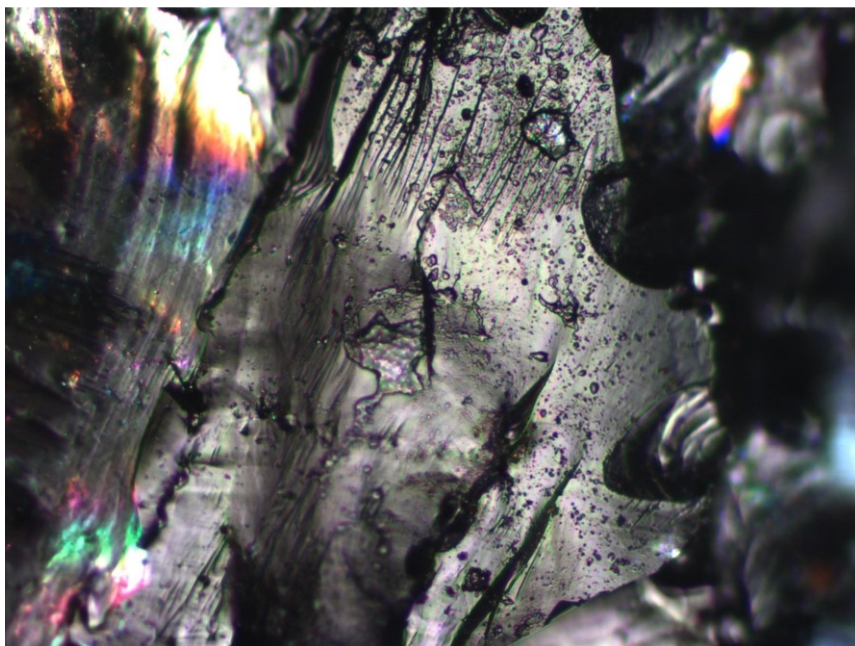
Sample Site **23** : Stone 1 : **Quartz**

Detail of Microscopic Image

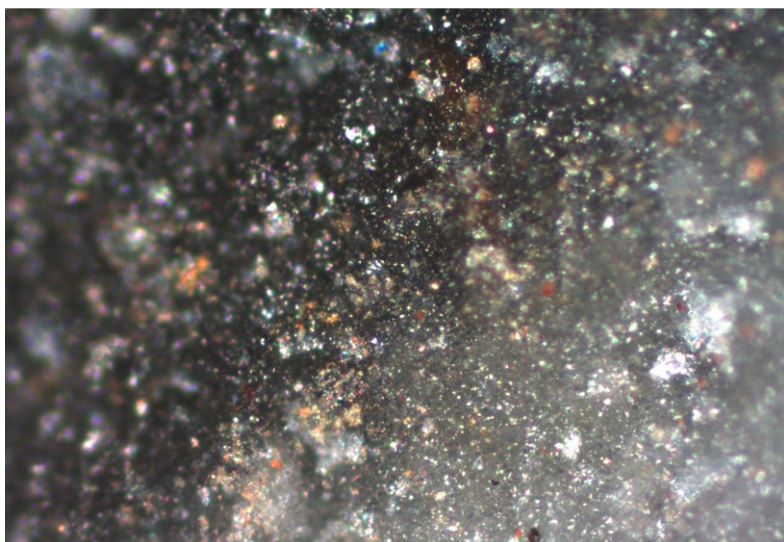
Image size : ~ 300 x 200  $\mu\text{m}$

Microscopic Images : Sample from Site 18, 21-A and 23 → original state ( no preparation for analysis )

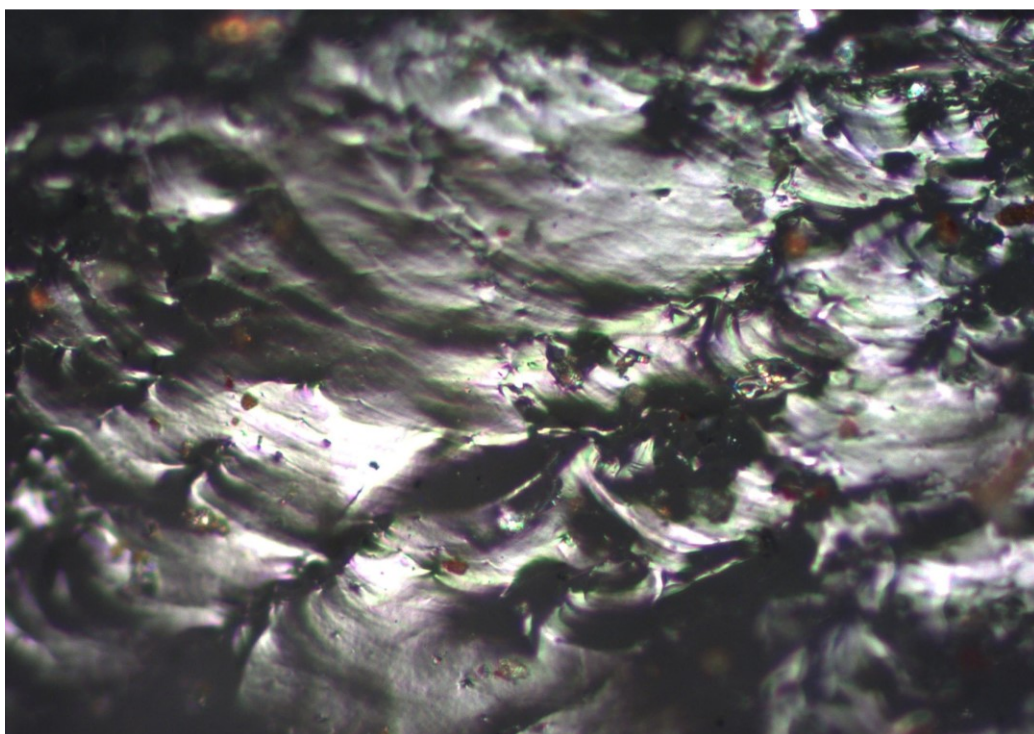
Sample Site **18** : Stone 1 : Quartz ( Image ~ 500 x 350  $\mu\text{m}$  )



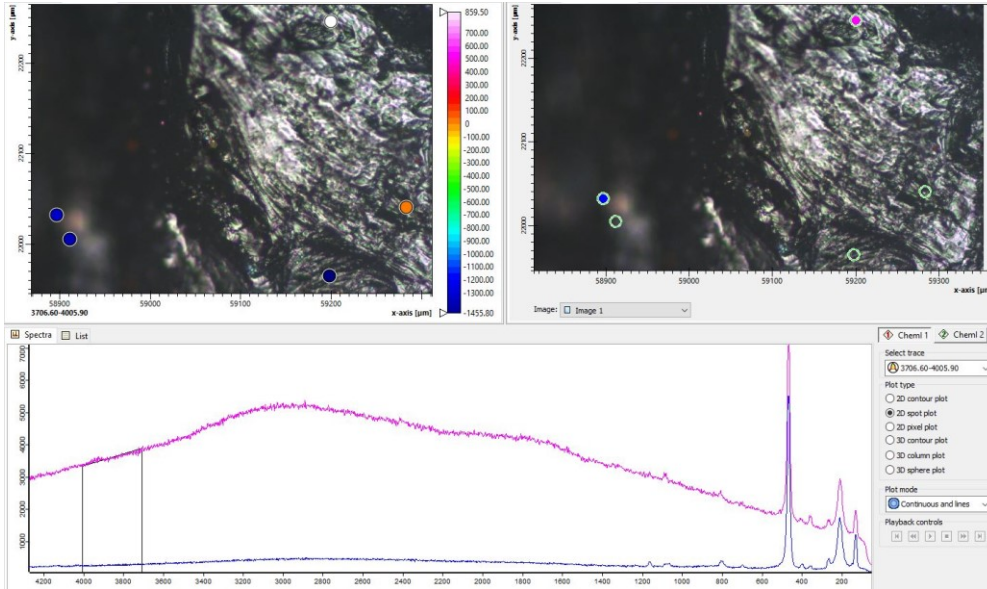
Sample Site **21-A** : Stone 1 : Quartz ( Image size : ~ 500 x 350  $\mu\text{m}$  )



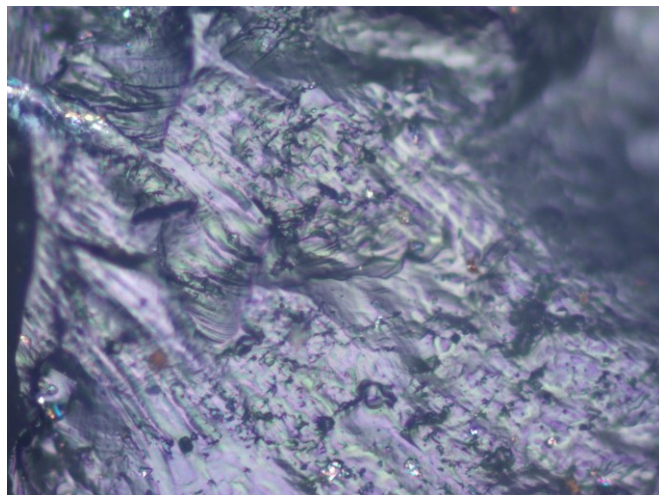
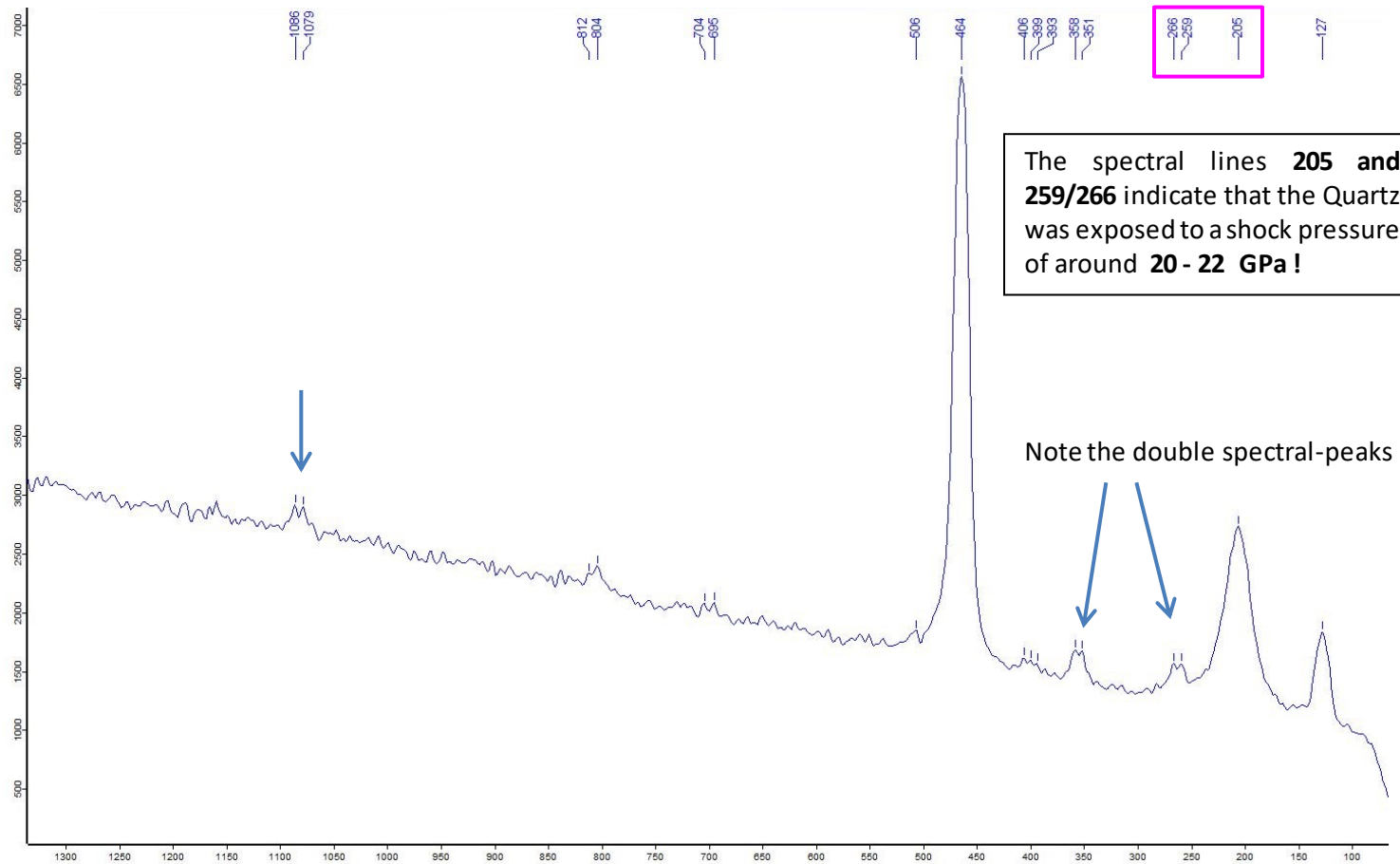
Sample Site **23** : Stone 1 : Quartz - ( Image size : ~ 550 x 450  $\mu\text{m}$  )



Sample Site **22**: Stone 1\_spectra 1 indicates: **Quartz**



Sample :

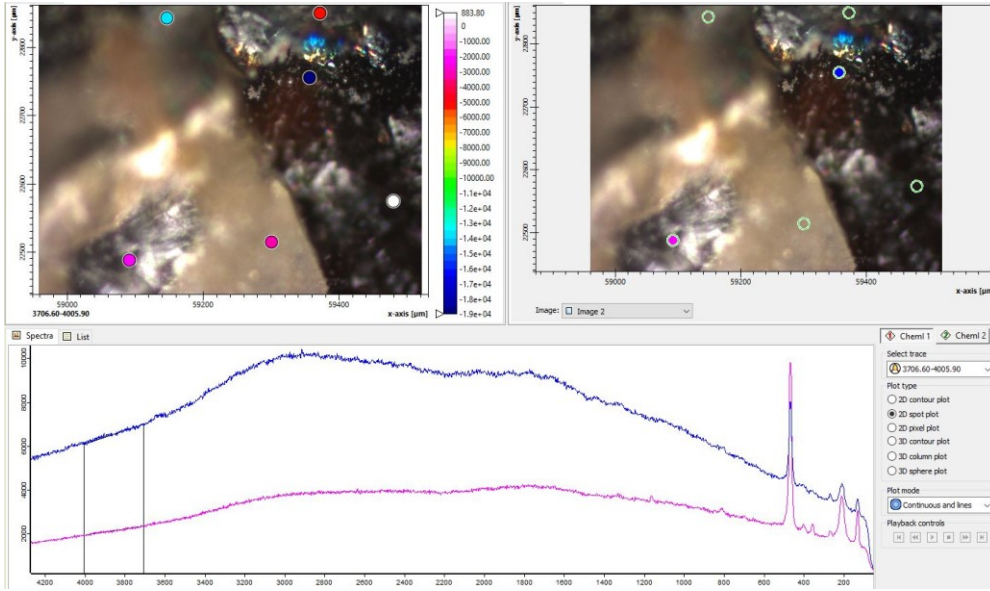


Sample Site **22**: Stone 1 : **Quartz**

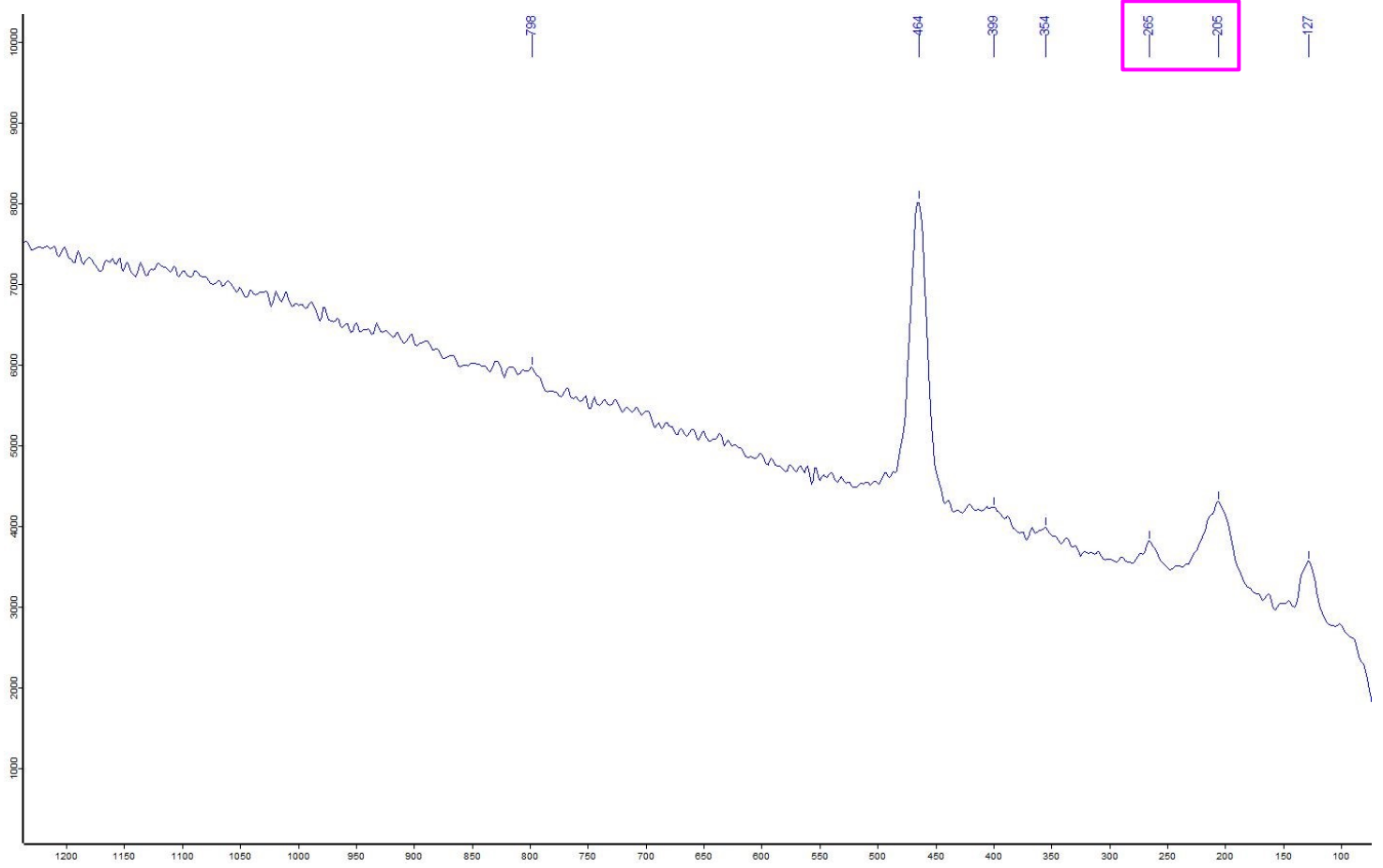
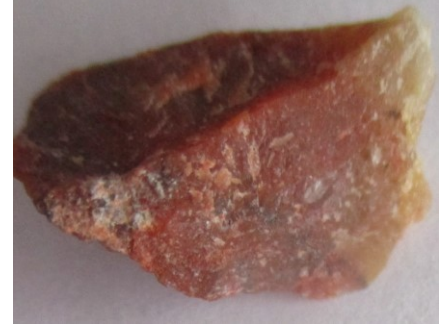
Detail of Microscopic Image

Image size : ~ 300 x 200 μm

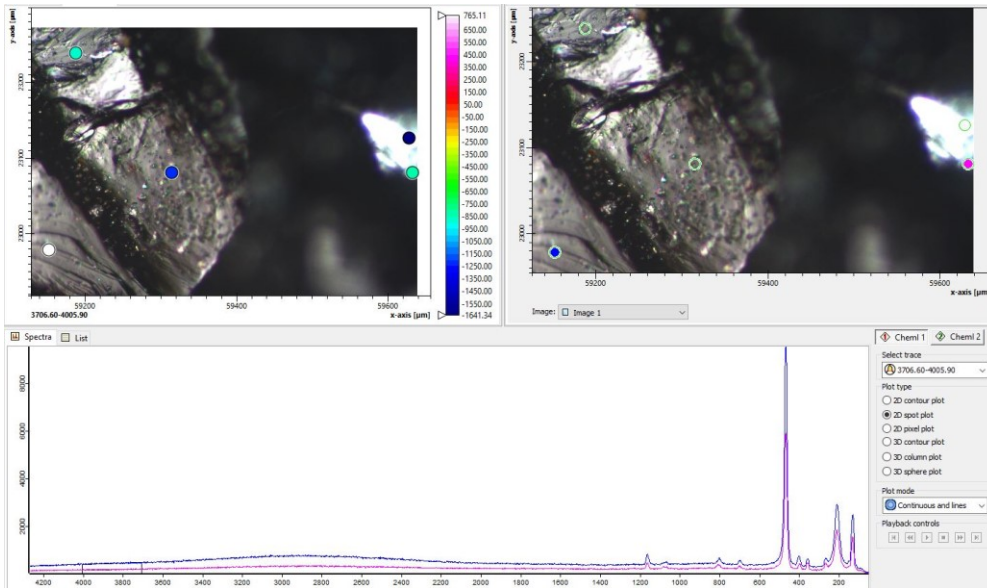
Sample Site 18: Stone 2\_spectra 1( blue spectra ) indicates: Quartz



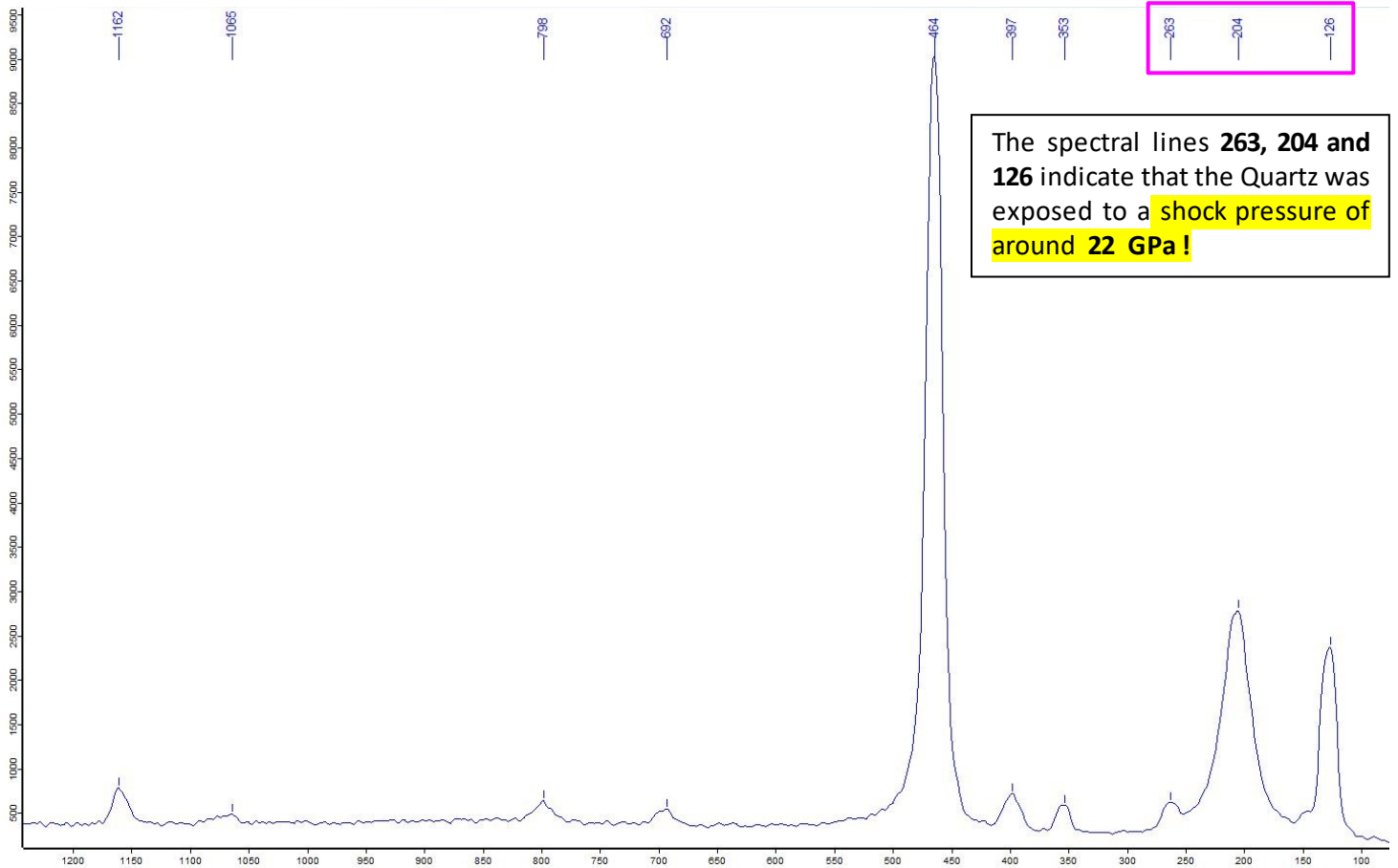
Sample :



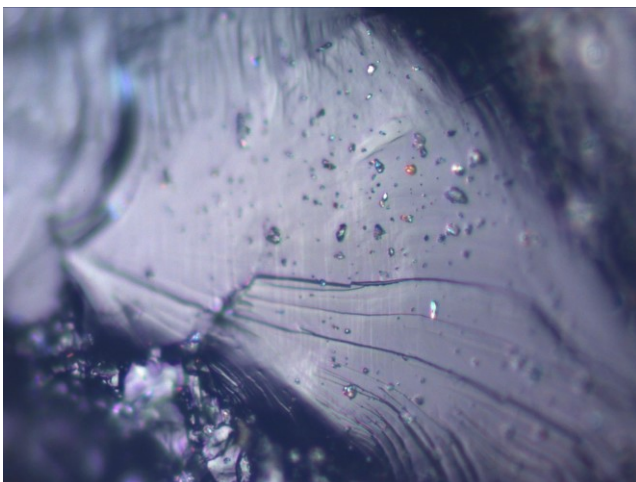
Sample Site **21-A** : Stone 2\_spectra 1 indicates : **Quartz**



Sample :



The spectral lines **263, 204 and 126** indicate that the Quartz was exposed to a **shock pressure of around 22 GPa !**



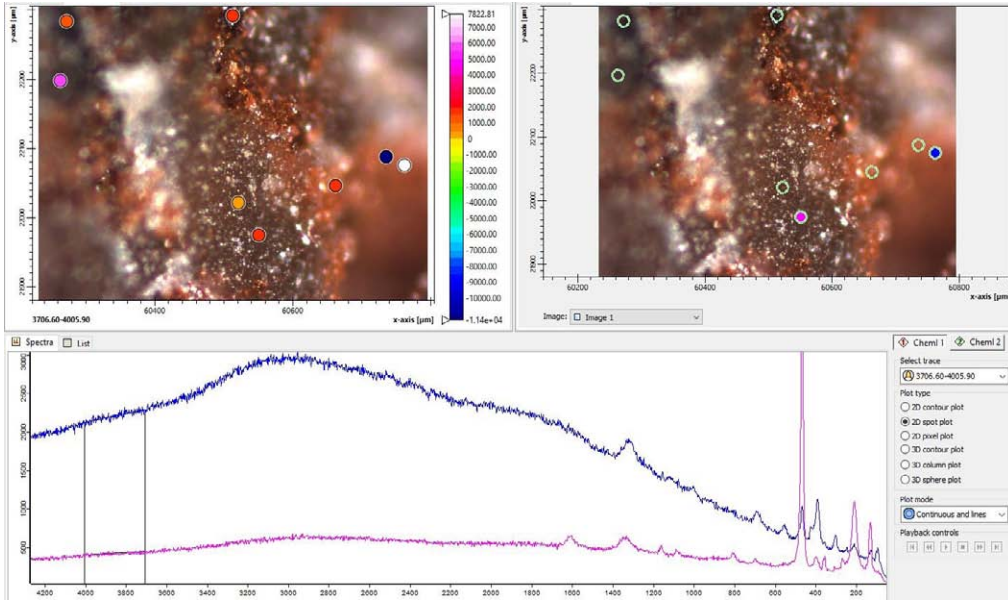
Sample Site **21-A** : Stone 2 :

**Quartz**

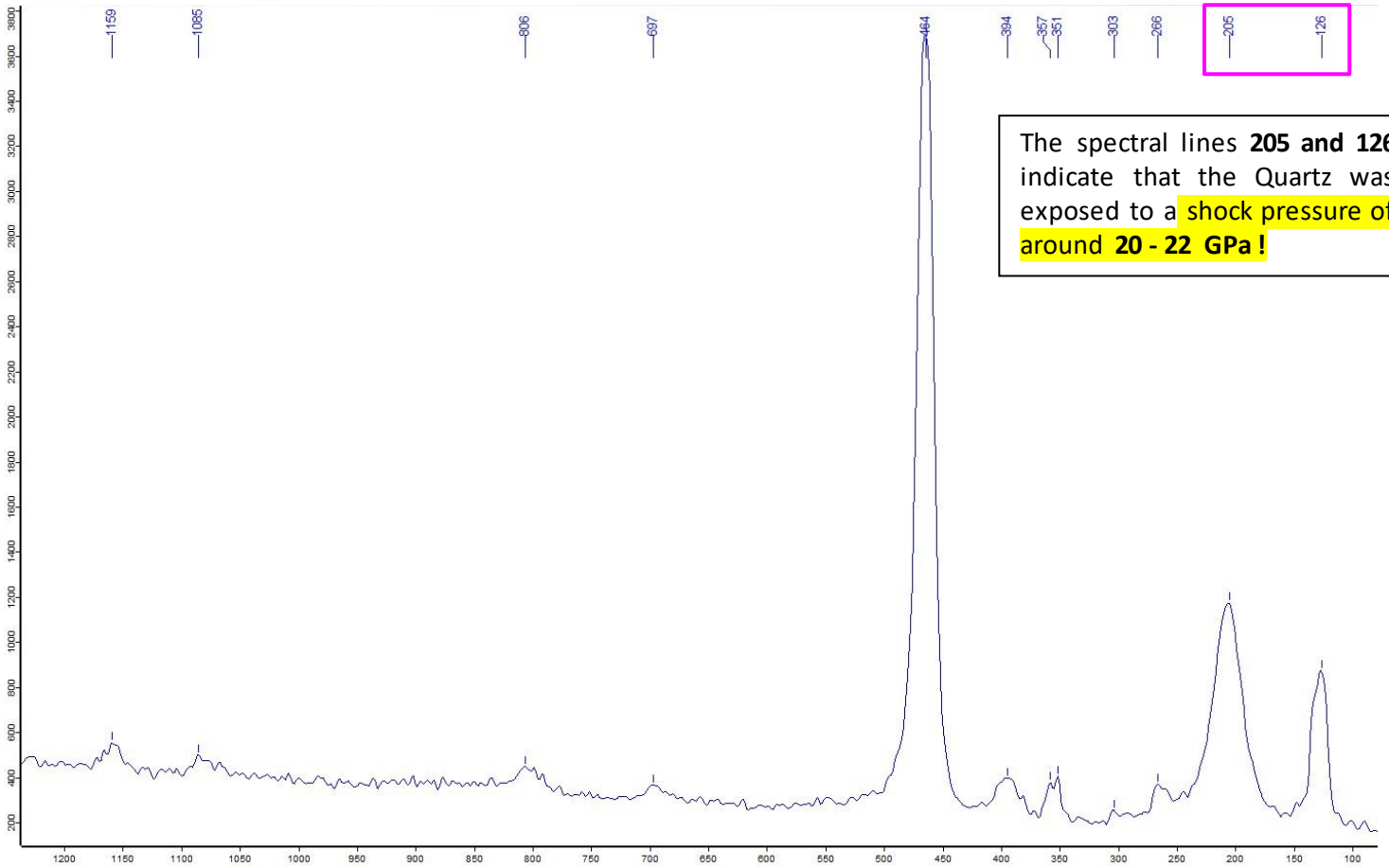
Detail of Microscopic Image

Image size : ~ 300 x 200 μm

Sample Site **21-A** : Stone 3\_spectra 1(pink) indicates : **Quartz**

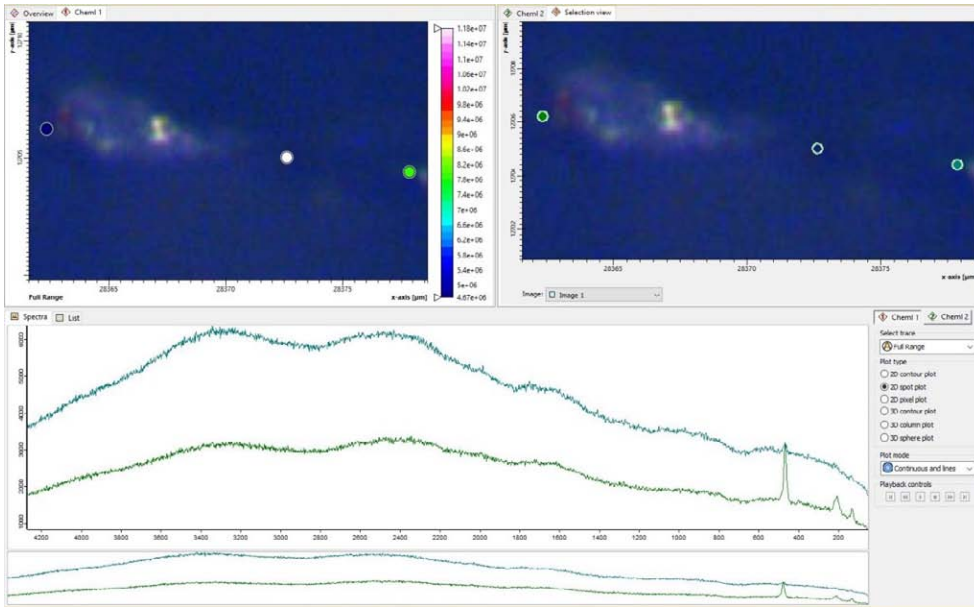


Sample :

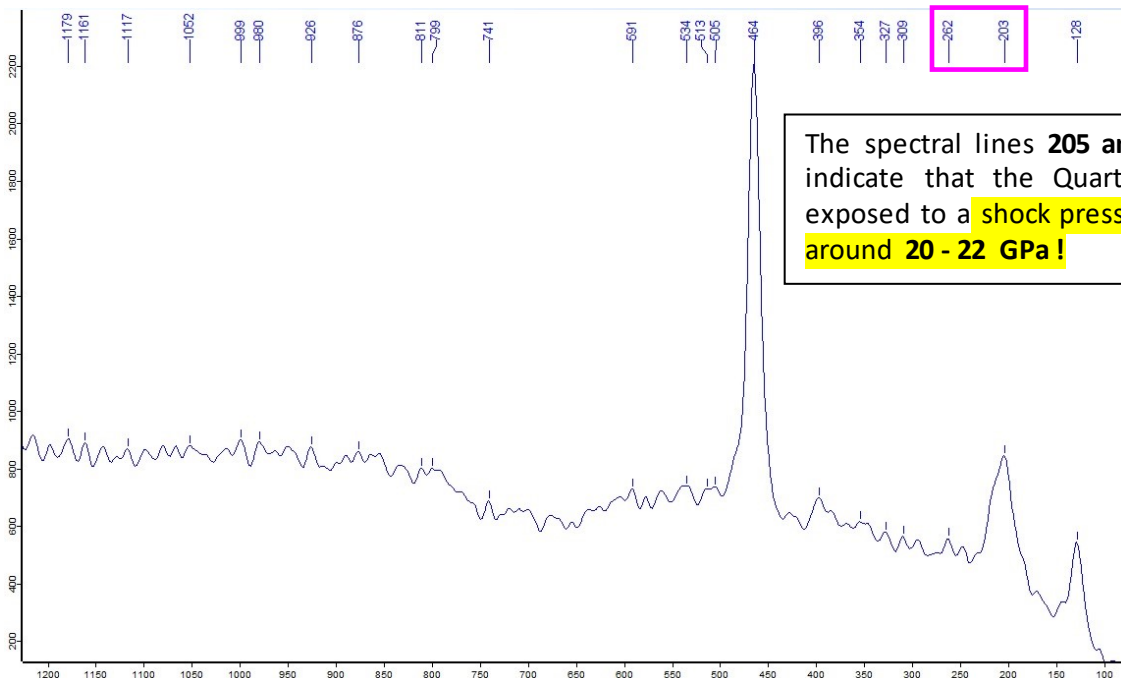
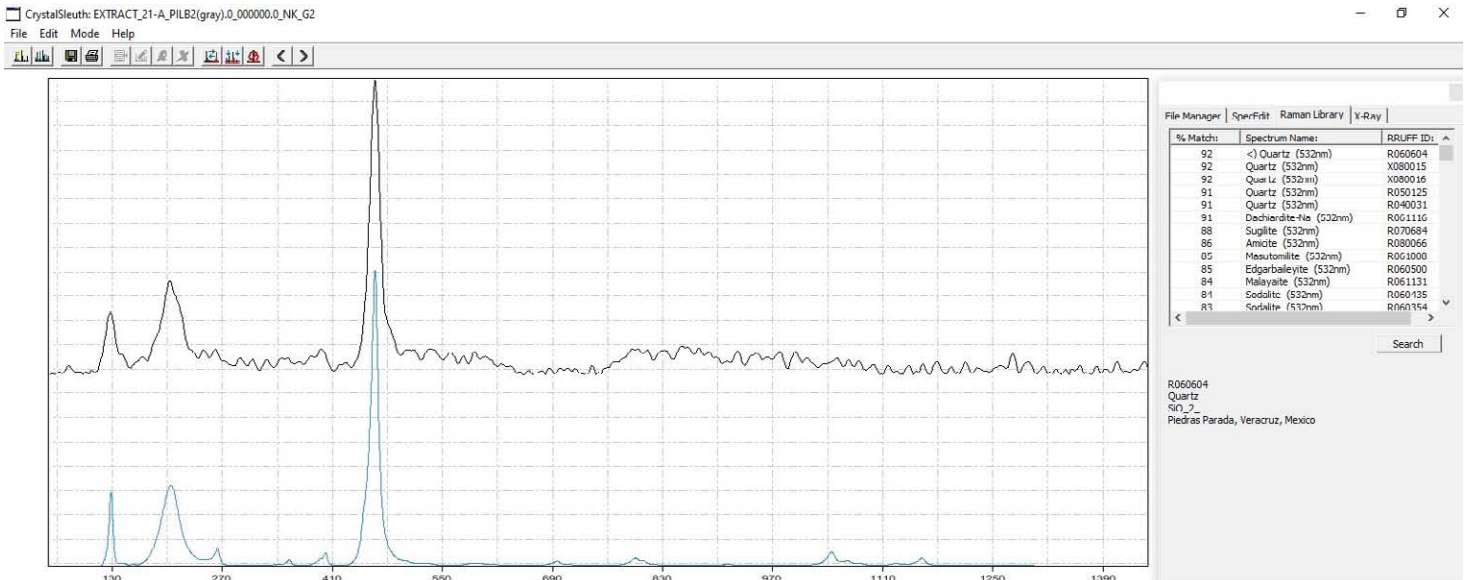


The spectral lines 205 and 126 indicate that the Quartz was exposed to a shock pressure of around 20 - 22 GPa !

Sample Site **21-A** : Stone 4\_spectra 1 ( grey mineral ) indicates : **Quartz** (→ see RRUFF\_CS results )

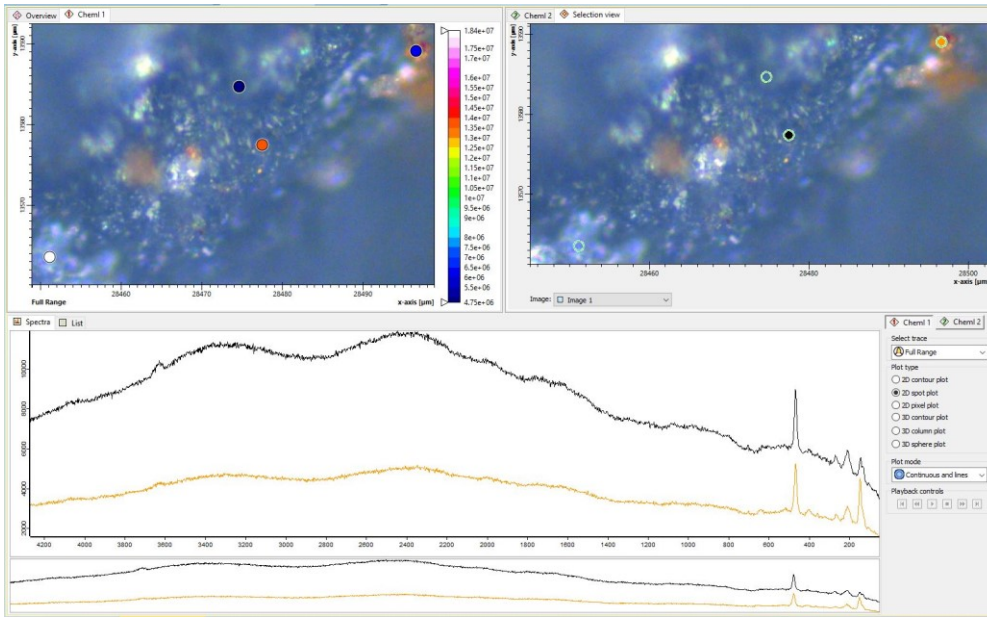


Sample :

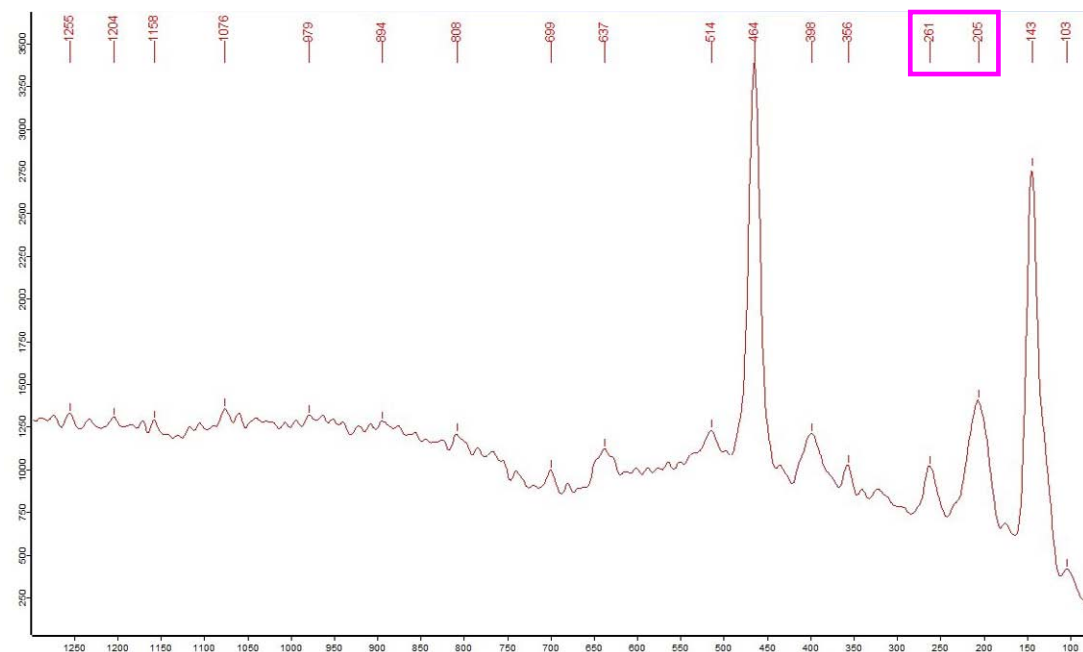
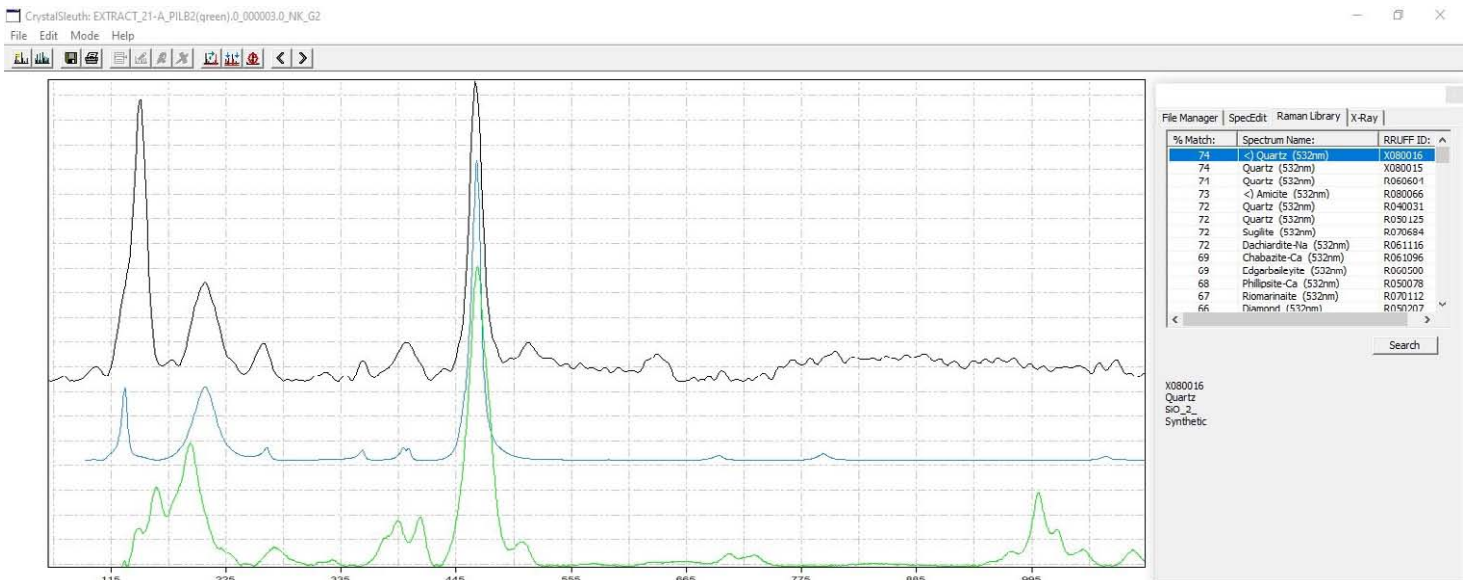


The spectral lines **205** and **128** indicate that the Quartz was exposed to a **shock pressure** of around **20 - 22 GPa** !

Sample Site **21-A** : Stone 4\_spectra 2 ( Green mineral ) indicates : **Quartz, Amicite** ( see RRUFF\_CS results )

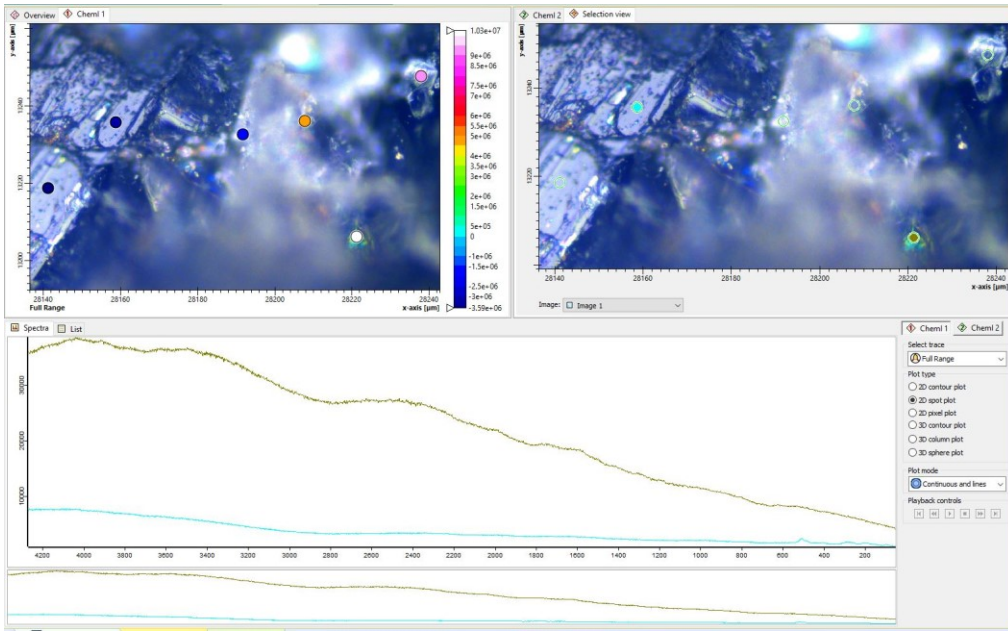


Sample :

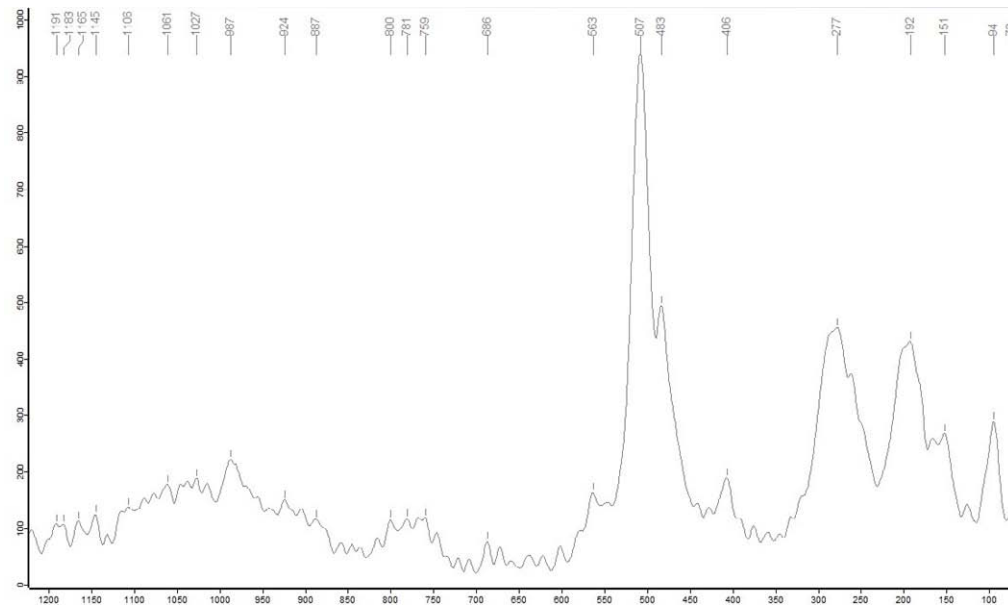
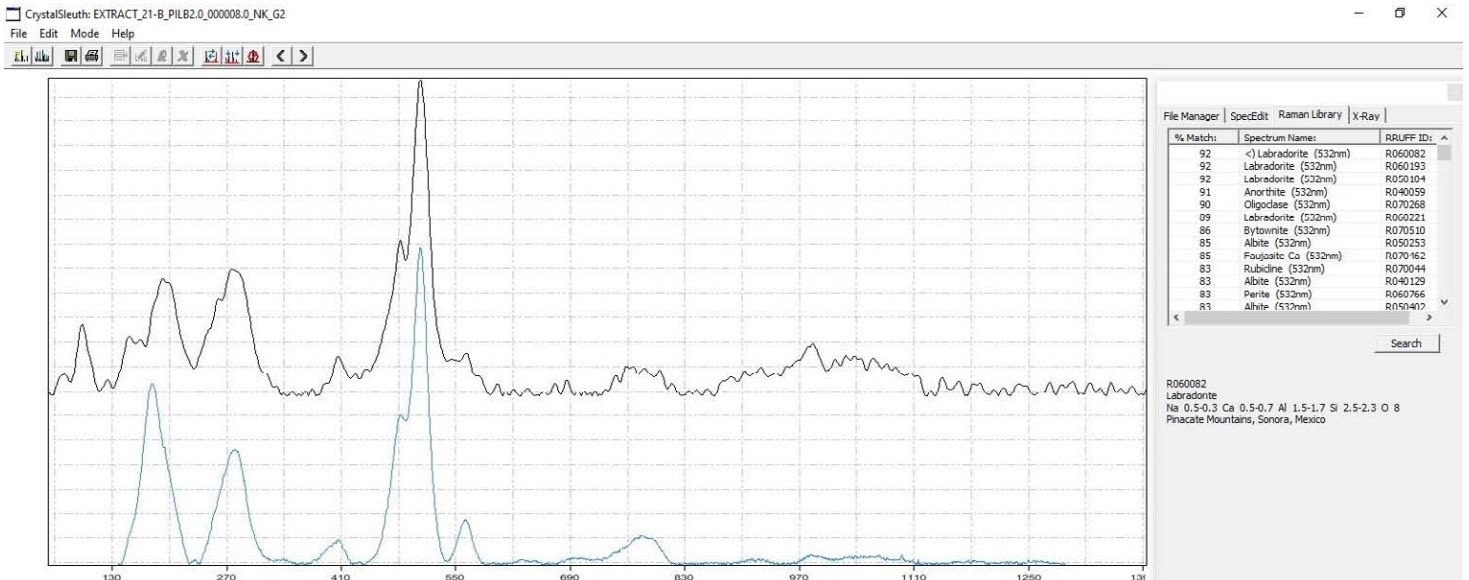




Sample Site **21-B** : Stone 3\_spectra 1 indicates : **Labradorite** ( → see RRUFF\_CS results )



Sample :

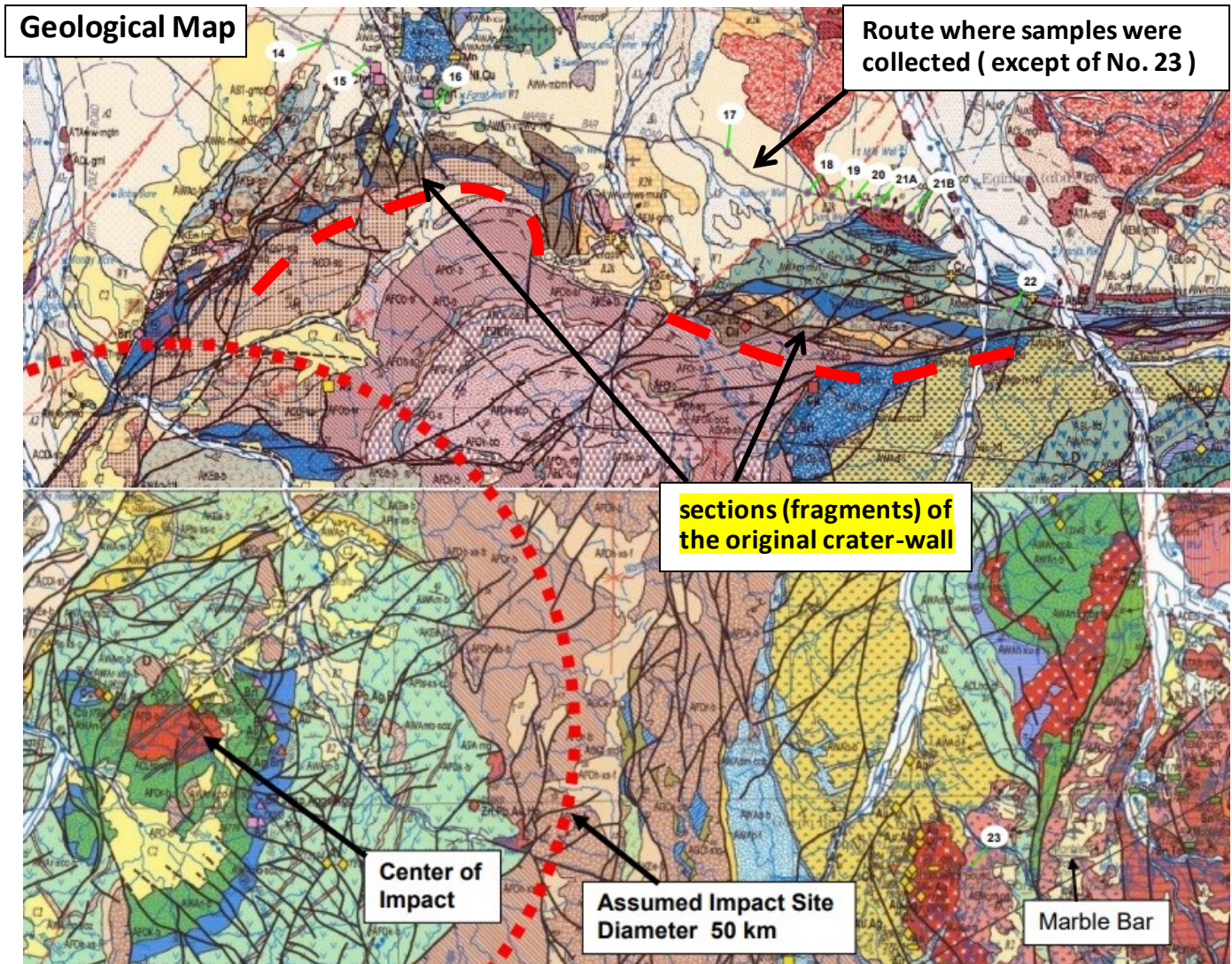


**Appendix 1 : Photos of the rock samples from the analysed sample sites :**

→ See next page !

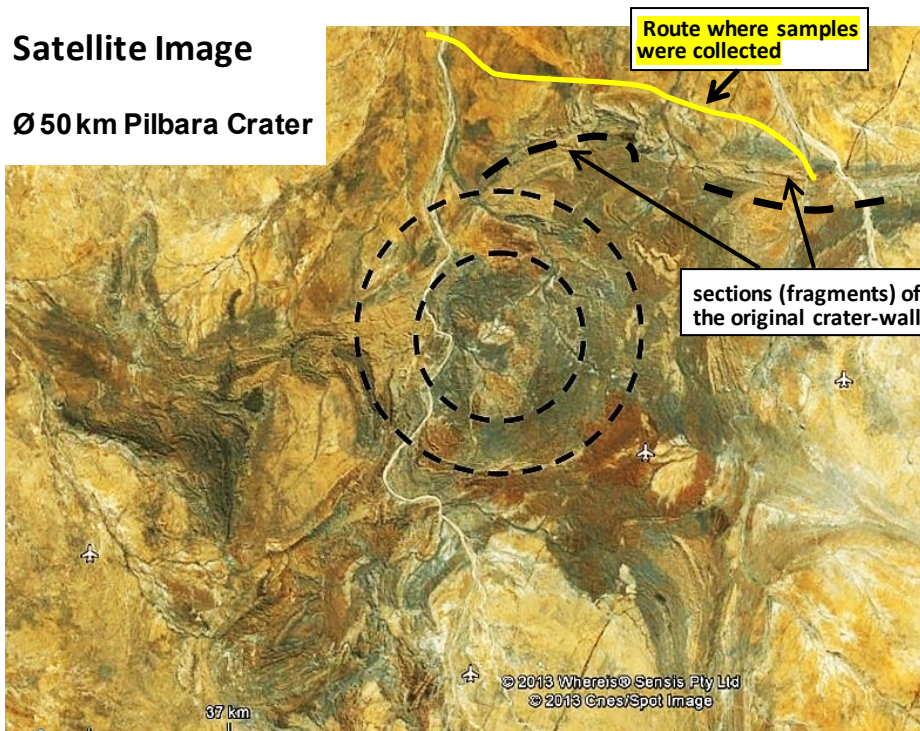
**Please note :** Photos of all Sample Sites & Rock Samples are available on my website :

→ [Samples Ø 50 km Pilbara Crater](#) or alternatively here : [Pilbara Crater](#)



**Satellite Image**

Ø 50 km Pilbara Crater

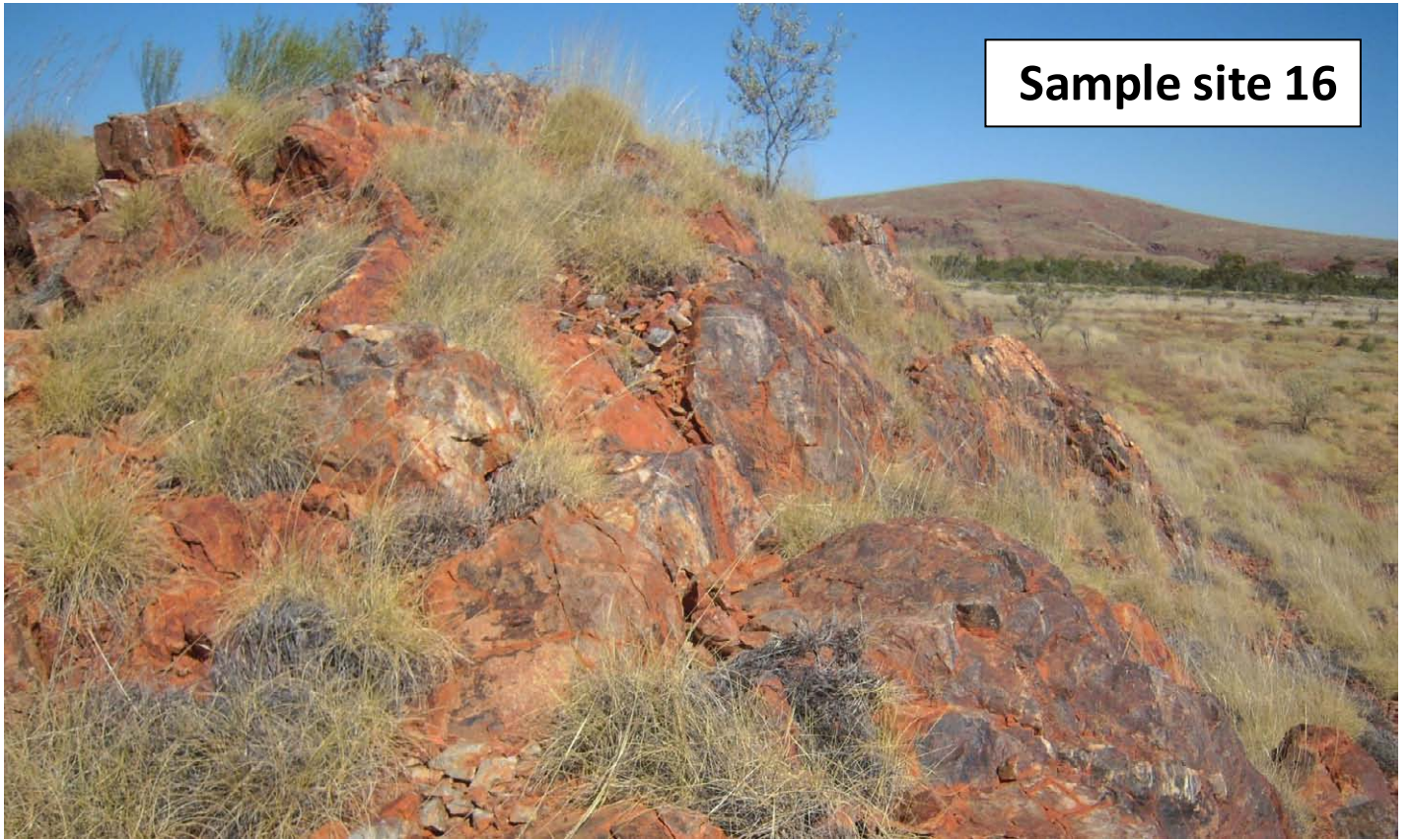


14



16

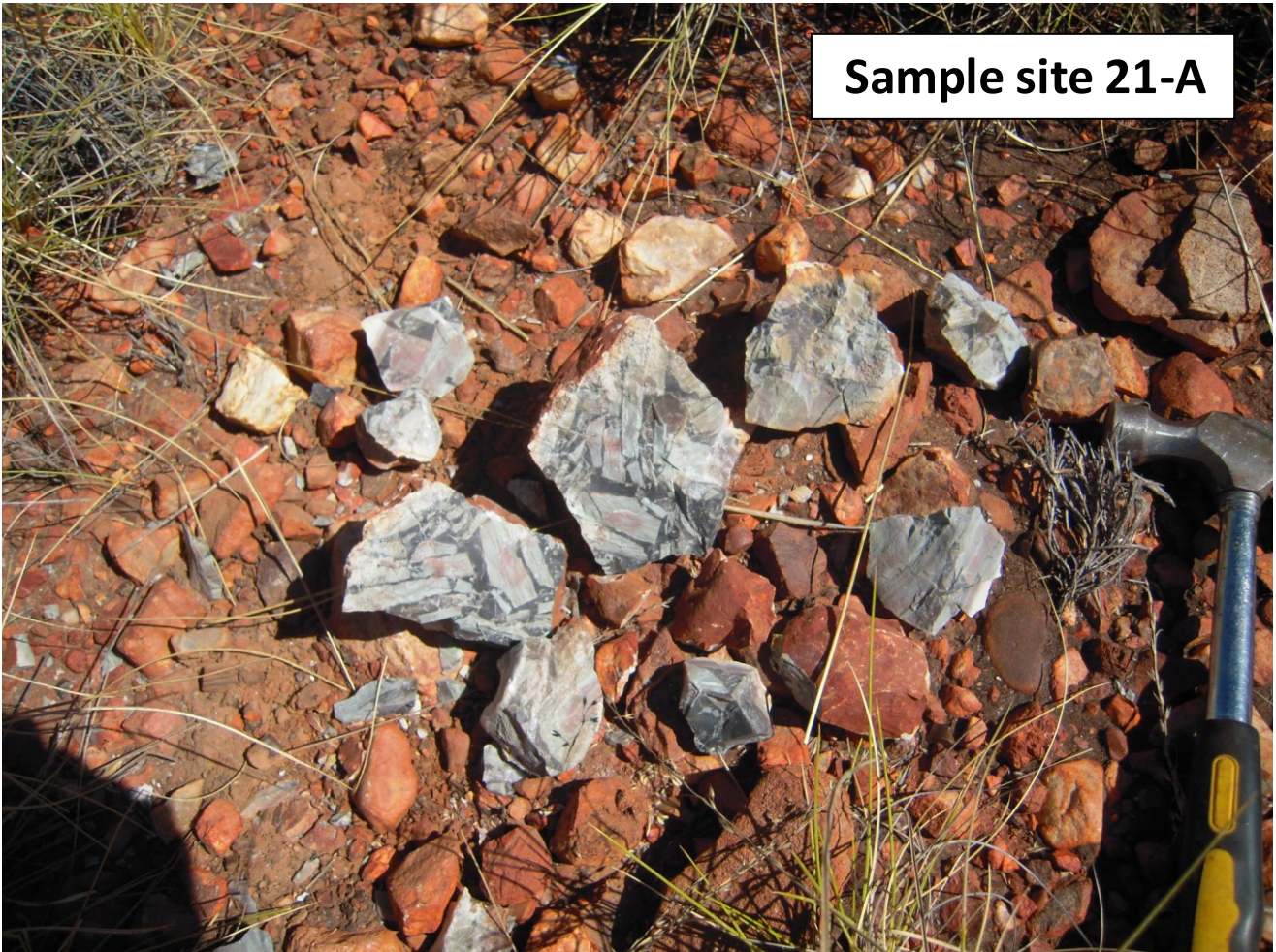


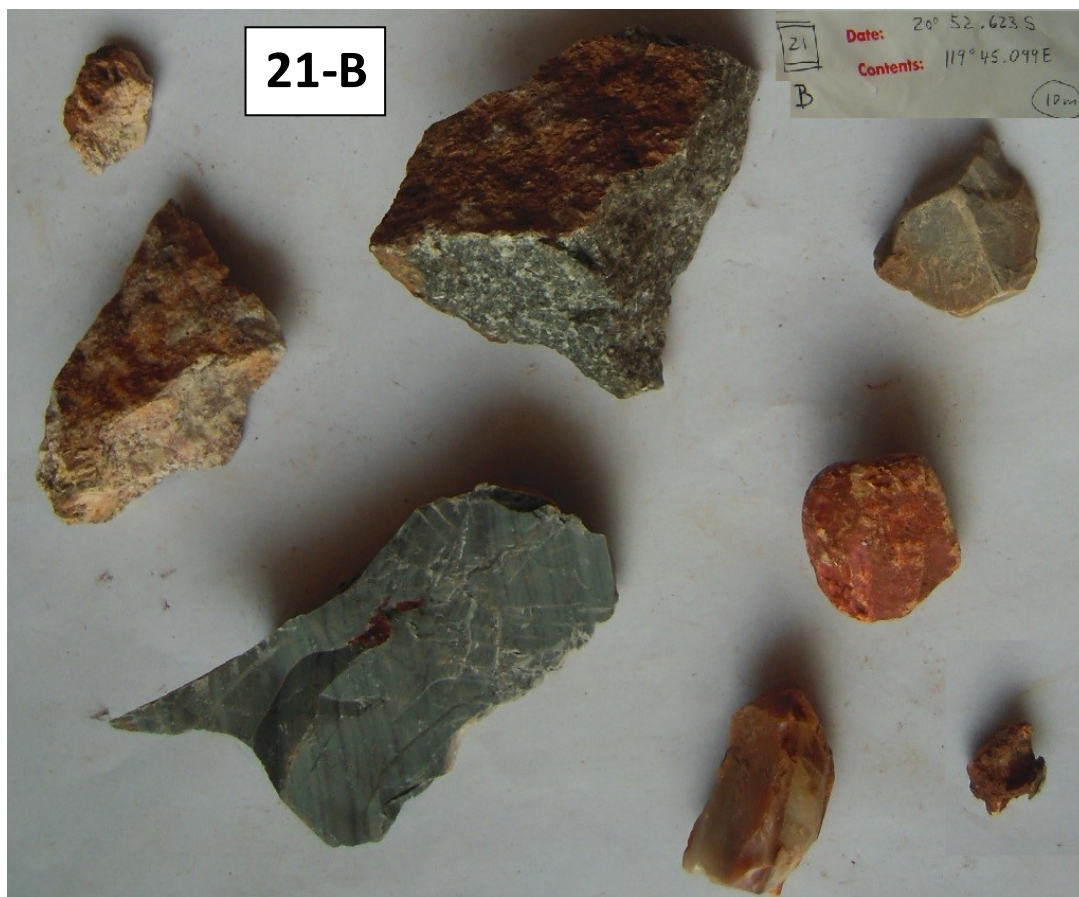


21-A



Sample site 21-A





**Sample site 21-B**  
**"A boulder hill"**



22



### Sample site 23

Accessibility to this site was a bit difficult, because there were aggressive gold-diggers on this land !  
I lost most samples from this site near Marble Bar !  
There were interesting structures in the rocks visible which probably showed fossilized stromatolite-like life-forms ! **Probably an interesting site for Archean-Paleontologists and Astrobiologists !**

23



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

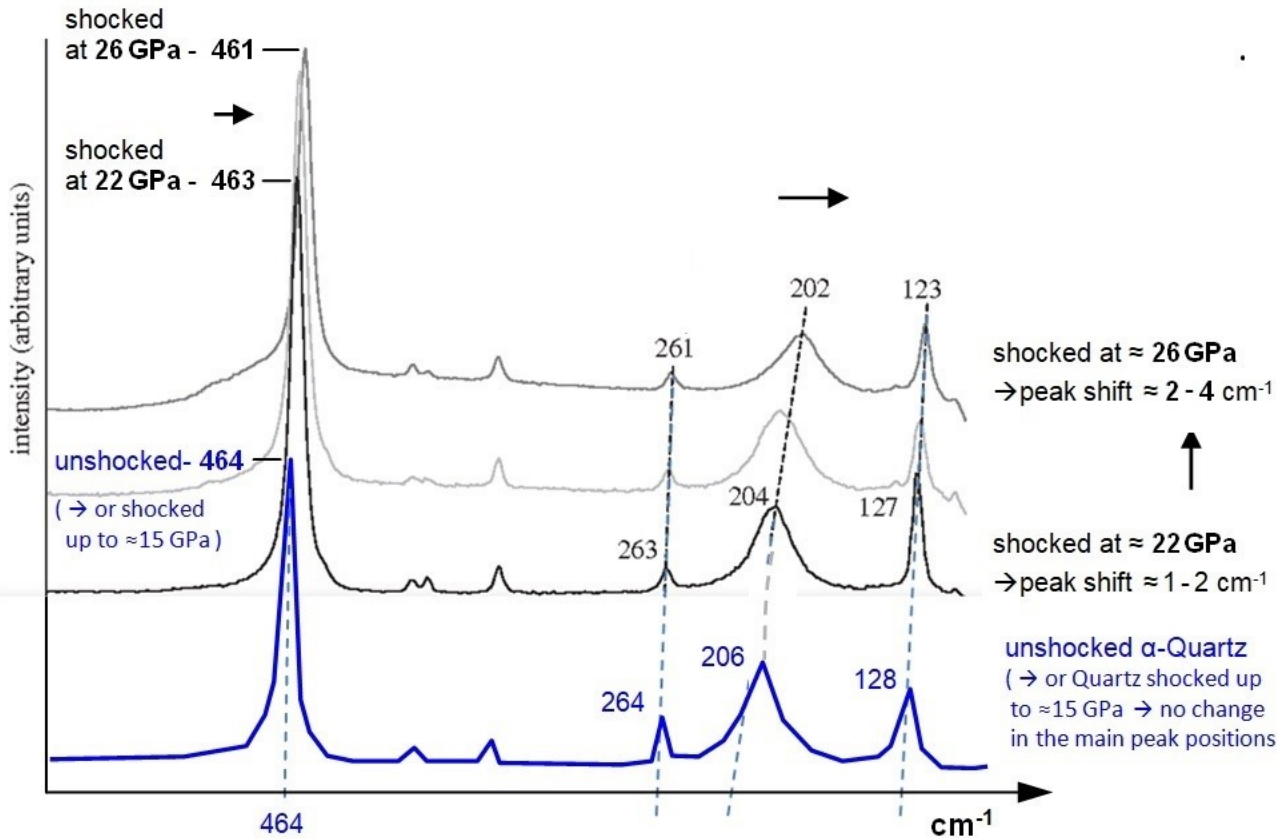
In order to verify a sample site as an impact site or impact structure, [shock-metamorphic effects](#) must be discovered in the rocks of the sample site. This can be done by different methods.

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.

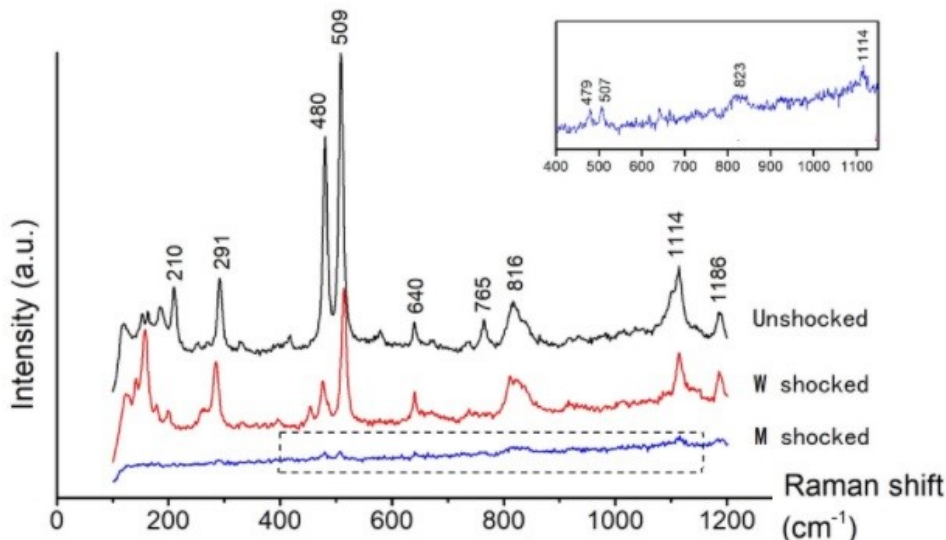
Mc Millan et al. (1992) and others have shown that the main RAMAN-peaks of Quartz shift towards lower frequencies if the Quartz was exposed the a shock-pressure > 15 GPa. → see diagram below

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<sup>-1</sup> 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 : [Samples Ø 50 km Pilbara Crater](#) ( or : [Pilbara Crater](#) )

**The 50 km Archean Impact Crater (Age >3 Ga) - Pilbara/Australia - A place where life on Earth started** - by Harry K. Hahn  
<https://vixra.org/abs/2101.0160> alternative : <https://archive.org/details/the-50-km-archean-impact-crater-age-3-ga-in-the-pilbara>

**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](http://www.permiantriassic.de) or [www.permiantriassic.at](http://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](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  $\alpha$ -quartz to CaCl<sub>2</sub>-like silica** - Journal of Applied Physics: Vol 96, No 8

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