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Shocked Quartz Distribution

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Investigation of Shocked Quartz

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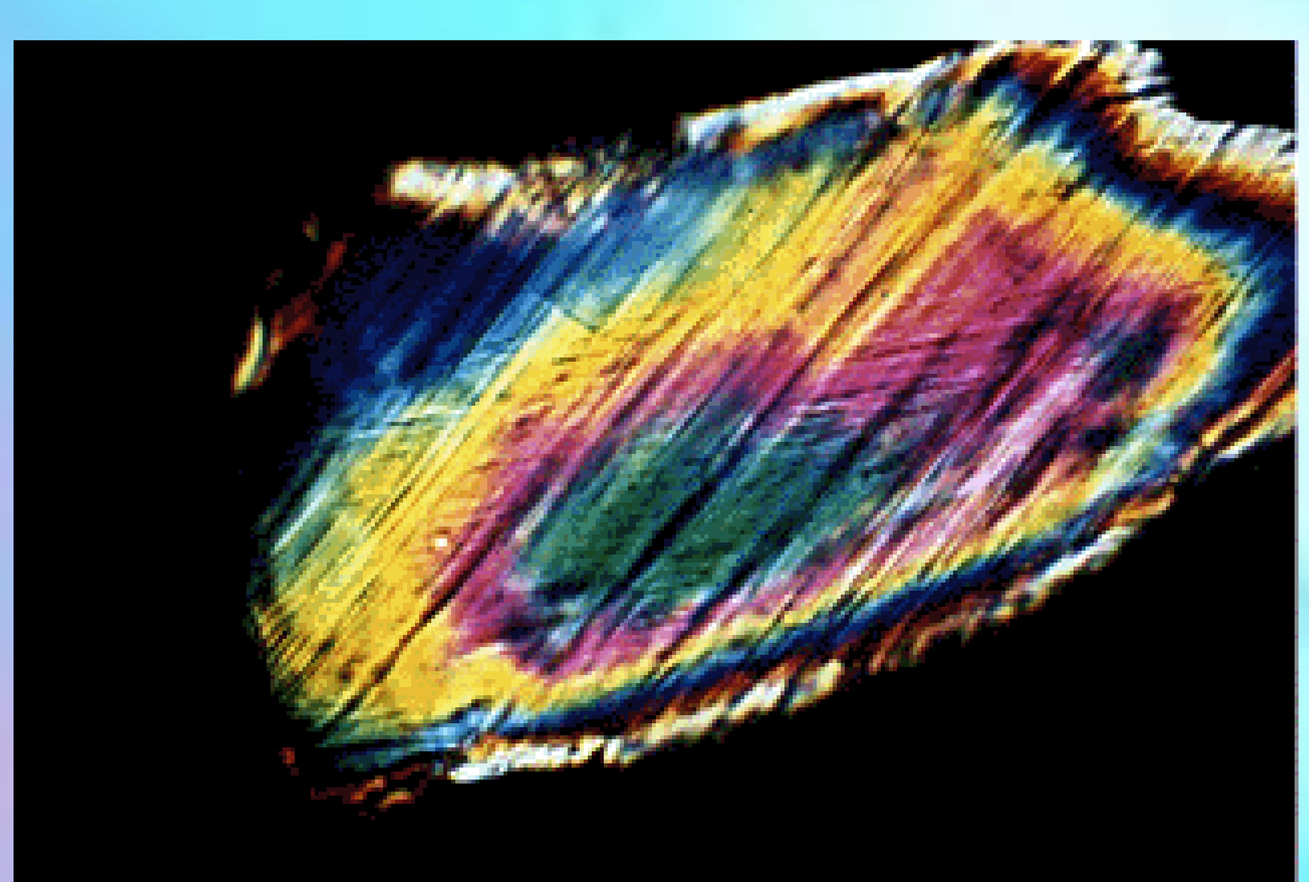
SUMMARY

Shocked quartz is typically used to test if sites experienced a meteorite impact in the past, however, sediment is readily transported by both earthly and extraterrestrial processes that blur the lines of where impact sites are on earth. The specific deformations in the clasts themselves reveal much about their origin and present location.

Conditions of Formation

- **Meteorite Impacts**
- **Interplanetary Collisions**
- **Nuclear Blasts**
- **High Impact Fault zones (Theorized)**
  - **High Pressure/Extreme Strain**
    - **Above 40 kbar**
  - **Low Temperature**
    - **Below 600 C**
  - **Low Water Content**
    - **Raises Melting Point**
- **Planar Features (PFs) are microscopically thin fissures spaced around 20 microns apart**
- **At higher temperatures and pressures planar deformation features (PDFs) and mosaicism predominate**
- **PDFs are microscopic, parallel zones within the quartz crystal, spaced at 2–10 microns apart and are arranged in specific crystallographic orientations based on shock pressure**
- **Mosaicism is shock-induced expansion of crystal volume that results in multiple crystal development within the original crystal**
- **These features are typically viewable under high powered electron beam microscopes, TEM, and FIB tomography that use cross polarized light to reveal small defects**

Figure 1
TEM Image of stage 1b shocked quartz under cross polarized light [3]



Characterizations and Special Properties

5 Stages of Deformation

- **Stages 0, Ia, and Ib, quartz display progressively greater numbers of PFs, numbers of planar deformation features PDFs, and extent of mosaicism**
- **stages II and III have high-pressure polymorph forms of pre-existing minerals where shock-produced melts can form**
  - **Polymorphs include stishovite and coesite, which have same SiO2 formula but different, more dense, internal atomic structures**

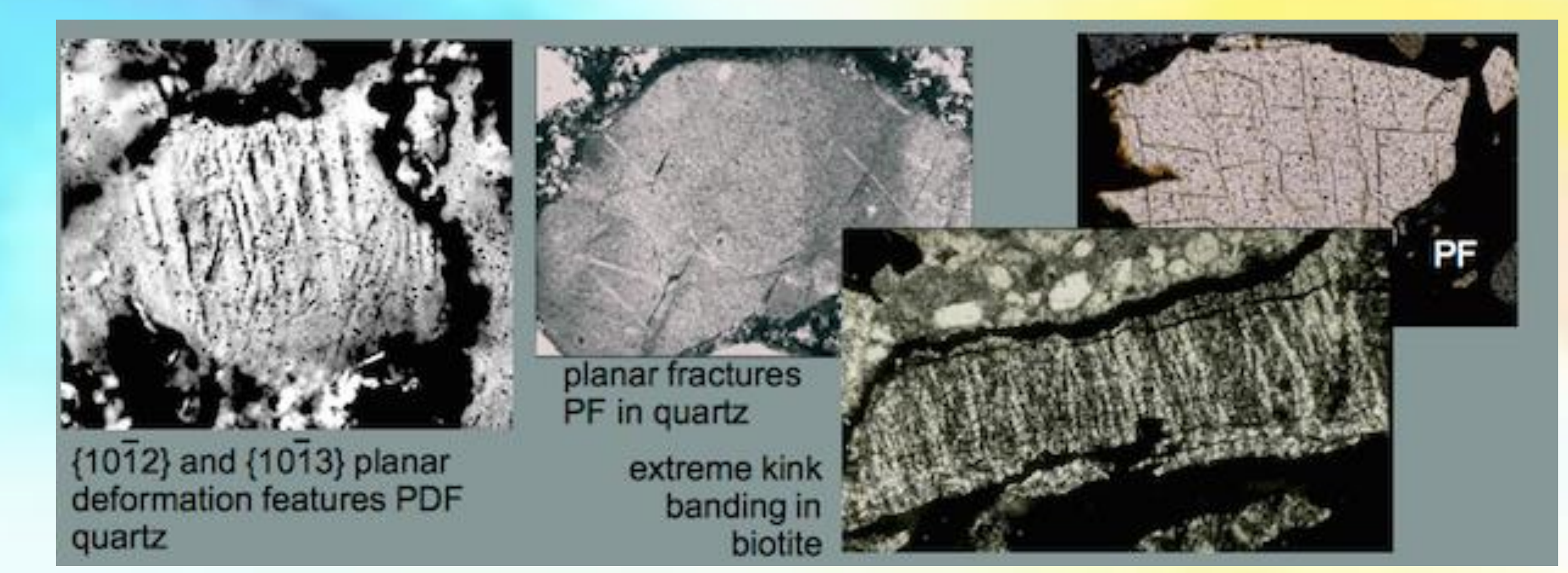


Figure 2 Images of Different Shocked Quartz Structures{4}

Luminescence

- **Crystalline quartz shocked parallel to the *X* axis is luminescent at pressures greater than 40 kbar in the X orientation**
- **Fused quartz and crystalline quartz shocked parallel to the *Y* and *Z* axes exhibited no luminescence at pressures below 120 kbar**
- **Alpha quartz, a piezoelectric material, shocked with high-explosive systems become intensely luminescent**
- **Luminescence appears in various patterns determined both by the pressure wave and orientation of the quartz**
- **Fused quartz shows weaker luminescence compared to crystalline quartz**

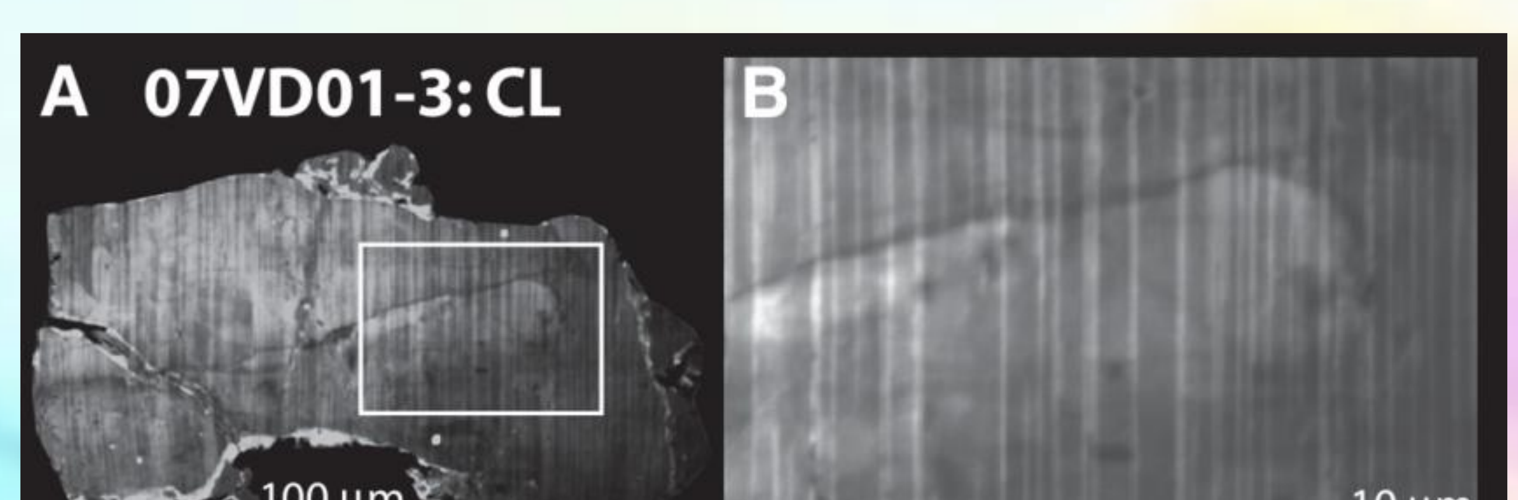


Figure 3
FIB image fo luminescent shocked quartz [5]

Deposits

- **Breccia around Impact sites**
  - **Alamo Basin, Central Nevada**
- **Reworked Fluvial Gravel**
  - **Sites around the Colorado River**
- **Global blanketing ash**
  - **KT Boundary**
- **Asteroid Blast Shrouds**
  - **Shocked Quartz developed from meteorite collisions in the Asteroid Belt and Oort cloud and then deposited on Earth's surface during upper atmosphere break up**

CONCLUSION

Shocked quartz has a variety of different depositional environments and a variety of properties that help geologists determine the conditions present during their formation. The presence of shocked quartz should not be a definitive sign of meteorite impacts but used as a tool to show that the area had been effected by extraterrestrial or high explosive activity in the past. Moreover, the different features present in the shocked quartz show their true origin and even help to give them luminescent properties. Shocked quartz is a very interesting phenomenon in geology that deserves more scientific exploration in the future.

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