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Petrography of impactites from the Dellen impact structure, Sweden

140 Million years ago, a meteorite traveling at tens of kilometers per second struck ground in what is today central Sweden. The impact formed an impact crater measuring at least 20 km across, Dellen. Powerful shock waves generated by the impact excavated a crater and gave rise to permanent microscopic deformations in the constituent minerals of the impacted area. Understanding these features advances our ability to improve knowledge on the crater-forming process, which is vital on all solid bodies of the Solar System.

Samples of impactites (rock-and sediment types created by the impact) have been retrieved from the shores of the Dellen lakes and examined with scanning electron and polarizing microscopes in hopes of furthering our knowledge of how minerals react to the shock waves generated during impact. Minerals such as apatite, magnetite, quartz, feldspars, zircon, biotite and titanite among others have all been affected by the event, showing unique deformation of the crystal lattice and recrystallization features, which can tell us what the conditions at the time of impact were. In this study, I have focused on apatite and magnetite. These are important minerals because of their potential impact on our knowledge of crater formation dynamics. When a mineral such as apatite undergoes metamorphism due to changes in temperature or pressure, it can release water and other molecules which can form atmospheres or oceans. Magnetic minerals are important because we can measure magnetism to learn about the surface changes of other planets such as Mars. Magnetite is by far the most important magnetic mineral in such measurements because of its abundance and ability to be magnetized. These minerals' recrystallization habits under shock wave exposure is therefore important to our knowledge of impact cratering dynamics.

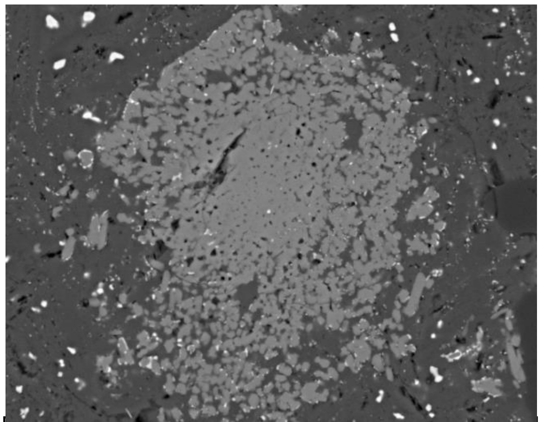

Image of A recrystallized apatite grain (light grey) which contains tentative vesicles visible as black dots central to the grain.

The magnetite grains from Dellen shows clear signs of having recrystallized into tiny sub-grains measuring 1 micrometre across in the most shocked samples. Such recrystallization into smaller crystals negatively affects the magnetic properties of magnetite and may be the cause of a widespread grading -7 mGal magnetic anomaly in the Dellen area. The investigated apatite crystals, aside from recrystallizing, show signs of having released part of their volatile contents, displaying what is thought to be vesicles created following the passage of the shock wave. EDS analysis of the apatite was inconclusive as to whether degassing had occurred, however. Whether shock-metamorphism can cause the degassing of apatite remains unanswered. Further research into the microscopic features found in apatite such as those found in Dellen could soon reveal an answer.

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