Key results (cf., MAPS 48, issue 1). At given impact conditions, craters in quartzite, dry sandstone and tuff, all have similar volumes, despite different target strengths. This is due to the inverse correlation of strength and porosity for most geological materials. Yet water-saturated pore space leads to larger crater volumes by reducing the dampening effect of porosity on the shock wave while keeping the target's strength. Analysis of projectile relics and mixed projectile–silicate target melts shows that Fe of the projectile is preferentially partitioned over Ni and Co into the target melt. This data has consequences in attempting to identify the projectile type in terrestrial craters via analysis of the "meteoritic component".

Whole rock geochemistry and zircon geochronology of the central Finnefjeld tonalite gneiss from the Maniitsoq impact structure, Western Greenland

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The proposed Maniitsoq impact structure, Western Greenland, has been described in extenso in the last three years by Garde and co-workers and is also prominently presented at this meeting. We here complement with an account of the whole-rock geochemical relationships of the central "Finnefjell grey gneisses" together with their zircon geochronology. The Finnefjeld gneisses form an almost circular ~40 km wide, central part of the interpreted Maniitsoq impact structure. We here present a Principal Component Analysis (PCA) evaluation of the tonalite geochemistry based on a field sampling in which strenuous efforts were made to secure specific representative samples (Theory of Sampling, TOS). Samples from 32 locations were treated with equal TOS-compliance w.r.t. laboratory mass-reduction and sample preparation, resulting in superior aliquots subjected to ICP-MS analysis at Cardiff University (11 major and 9 trace elements). The Maniitsoq tonalities are of remarkable uniform composition with only minor variations, a feature that perhaps may reflect extensive, massive acoustic fluidization homogenization. Alternatively, it may represent original characteristics from the Mesoarchean (>3 Gy) original tonalite magmas or manifestations of both processes. In order to unravel this ambiguity, both geochemical, petrographic and isotope studies are called for. Zircons affected by short lived extreme pressures and temperatures during impacts may preserve structural and isotope geochemical evidences of the impact. Zircon from the Finnefjeld gneiss show crystallographically oriented fractures that may be caused by deformation at very high pressures. Crushed zircons are common in the Finnefjeld gneiss. Zircons from 12 geographically well distributed samples were selected for geochronological and micro-textural analysis (ongoing research at the time of abstract submission). Results from U-Pb ion probe datings (Nordsim) will be presented.

Definitive criteria for meteorite impact — What to look for?

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On Earth, the identification of meteorite impact craters need to be supported by distinctive impact-metamorphic effects in rocks and minerals (i.e., unique products of impact-generated shock waves) and/or by a chemical or isotopic signature from the projectile itself. Shatter cones (distinctive multiple sets of striated conical fractures) are the only distinctive shock-deformation feature that can be seen with the naked eye. At the microscopic scale, minerals frequently display irregular fractures (which are not diagnostic shock effects), but in case the involved pressure was strong enough, planar microstructures may have formed. These microstructures include: planar fractures (PFs; by definition planar, parallel, thin open fissures), feather features, and planar deformation features (narrow, individual planes, comprising straight, parallel sets; generally occurring as multiple sets per grain). However, when occurring alone, PFs and feather features are not regarded as definitive criteria. At high-pressure regimes, diaplectic glass forms, while melting of individual minerals and of the whole rock starts at even higher pressures. However, the formation of glasses and/or melts does not necessarily require high shock pressures and can occur through non-impact processes (e.g., in fulgurites). High-pressure phases, for example, coesite, stishovite, or diamond are diagnostic features of meteorite impact. However, the use of such high-pressure phases to confirm impact structures must be applied with caution, as coesite and diamond are also products of endogenic processes. In some rare cases, the identification of an impact crater can also be based on the occurrence of meteorites spatially associated with a structure. Finally, the last definitive criteria reliable as evidence for a meteorite impact event is a chemical and/or isotopic signature from the projectile, with for example the detection of siderophile elements or isotopic (Os, Cr) anomalies in specific geological settings. Today, about 185 impact structures have been unambiguously identified on Earth based on these criteria, excluding the "Maniitsoq structure" (West Greenland).

Mechanical mixing of impact-generated feldspar liquids in the Maniitsoq structure, West Greenland

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The up to 80 km wide melt zone of the deeply exhumed, 3.0 Ga Maniitsoq impact structure displays unique K-feldspar – Plagioclase melt textures created by oscillatory mechanical mixing immediately after the impact. Contrary to impact-generated mineral melts in the upper crust, which are typically preserved as devitrified glass, the deep-crustal mineral melts at Maniitsoq are preserved as monocrystalline grains that mimick each melt patch.

K-feldspar and plagioclase occur in three morphological types located side by side, namely monomineralic areas, lobate tongues of partly mixed K-feldspar and plagioclase, and intercalated mesoperthite. The individual feldspar compositions are identical throughout all morphological types. Quartz forms irregular patches with lobate, commonly concave margins as well as tiny, spherical grains. Fractures are common in monomineralic areas, rare in mixed-feldspar areas, and absent in the mesoperthite. The simple mineralogy and uniform feldspar compositions imply that the unique feldspar microtextures were formed in situ and without solid-state reactions except for mesoperthite exsolution. The lobate, interfingering texture documents feldspar magma mixing on a microscopic scale. We interpret the microtextures as products of shock melting, incomplete mechanical mixing between K-feldspar and plagioclase liquids during impact-induced seismic oscillation, and subsequent exsolution to mesoperthite where feldspar magma mixing was complete.

The feldspar microtextures in granitic rocks of the Maniitsoq melt zone constitute compelling evidence of impact/shock melting and document impact-induced crustal reverberation during the sequential solidification of the individual and mixed feldspar melts.