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Nanostructures of the 4.2 Ga Acasta zircon

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The mineral zircon ($ZrSiO_4$) has been recognized as valuable material for isotopic geochronology, especially for ancient rocks. However, its structure is often disturbed by radioactive decay, causing metamictisation and thus mobility of various elements. The discovery of Pb clusters in grains from UHT gneisses from the Napier Complex in East Antarctica [1], and the formation of metallic Pb nanospheres [2] altered U–Pb dates and caused more detailed work on zircon in micro- and nanoscale targeting samples from various geological environments (e.g. Kerala Khondalite Belt in India [3] and Jack Hills in Australia [5], [6].

Following work on the most ancient crystals on Earth from Jack Hills, selection of the oldest rock, the Acasta Gneiss from Northwestern Canada [7], was a natural choice. The xenocrystic 4.2 Ga grain was analysed by TEM. The zircon grain contains a mixture of metamict and crystalline domains with the xenocrystic core more crystalline than the rim. Other features documented include nanopores with traces of Y and U, healed cracks with traces of Al and Fe, and metallic Pb nanospheres up to 10 nm. Pb nanospheres are present in both, more and less crystalline parts of the zircon, however the latter contain more spheres. Sometimes Pb co-exists with Fe-oxide particles.

The Acasta zircon adds more to the group of zircons with Pb nanospheres present. The formation of Pb nanospheres is a complex process with different mechanism influenced by many factors operating in difference rocks. Microstructure indicates that dissolution-reprecipitation process influenced these zircons, what distinguishes them from all other samples earlier documented.

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References:

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