

COMPARATIVE PETROGRAPHIC, GEOCHEMICAL, AND ISOTOPIC CHARACTERIZATION OF DISTAL EJECTA LAYERS

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Introduction:

Collision and impact crater formation represent one of the most fundamental geological processes in the Solar System, with important consequences for the formation and the evolution of the surface and/or the atmosphere of planetary bodies. In the case of the Earth, these high-energy phenomena can also affect life on a local and/or global scale (e.g., the Chicxulub impact [1]). During hypervelocity impact events, target lithologies are vaporized, melted and fractured as well as mixed with projectile (i.e., meteoritic) matter. The formation of large impact structures can be accompanied by the production of a specific type of deposits called ejecta, often distributed over vast areas. These layers are largely composed of crushed and melted dust and rock fragments. More than 2.5 crater diameters away from the source crater, these layers are called distal ejecta [2], which are not commonly preserved. Beyond 10 crater diameters from the source crater, the ejecta layer is primarily composed of glassy impact spherules of less than 1 mm, which represent solidified melt droplets and vapour-condensates. If primary crystals are present within the spherules, these impact spherules are called microkrystites, otherwise they are called microtektites. Compared to the 190 confirmed impact structures on Earth, only roughly 30 distal ejecta layers are currently known, and only c. 7 impact structures have been directly linked to distal ejecta layers [2].

To verify the impact origin of terrestrial spherules layers, petrographic (e.g., glassy and altered spherules, Ni-rich spinel crystals, shock-metamorphosed mineral grains), geochemical (e.g., Ir anomalies and other siderophile element enrichments), and isotopic (e.g., Cr and Os isotopic data) characteristics are mostly used. Together with tectonic, stratigraphic, and geochronological information, these indicators for impact cratering have also been used to group different spherules layers together (e.g., Paraburdoo-Reivilo [3]) and to suggest potential source craters (e.g., spherules in the Zaonega Formation may be linked to the Vredefort impact structure [4]). However, the products of ejecta formation can be highly diverse, as well-illustrated by the Chicxulub case, where crushed, melted and condensed material was deposited in different types and proportions across the globe. This work focuses on the extensive collection of proximal and distal ejecta from various locations and time intervals available at the Vrije Universiteit Brussel by using petrography, SEM-EDS, and novel geochemical techniques such as μ XRF and LA-(MC-)ICP-MS. This way we aim to provide better constraints on impact spherule formation through time and to confirm or disprove the links between specific spherule layers and with particular impact structures.

References:

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