COMPOSITIONAL VARIATIONS & PETROGRAPHY OF METALLIC SPHERULES IN MELT ROCK AT MONTURAQUI CRATER, CHILE. D. W. Peate[1] I. Ukstins Peate[1], L. Chung Wan[1] and C. Kloberdanz[1], [1]Department of Geoscience, University of Iowa, 121 Trowbridge Hall, Iowa City, IA 52242, USA, david-peate@uiowa.edu

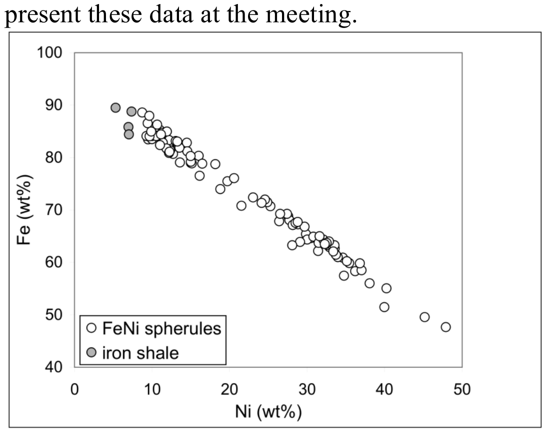
Introduction: Small impact craters (< 1-2 km dia.) have unique features that raise the possibility of using chemical studies to constrain the nature of physical processes that occurred during impact. Such craters are almost exclusively formed by iron meteorite impactors, with low enough kinetic energy that not all the projectile is vaporized and lost from the impact site. Fragments of unmelted meteorite material can survive, and droplets of FeNi metal are often found dispersed around the impact site and mixed with melted and fragmented target rocks. Studies of these 'spherules' show they are compositionally variable in terms of Fe-Ni-P-Co and different in composition from unaltered iron meteorites [1,2,3]. Several models have been proposed to explain compositional variations in spherules at different impact sites: vaporization-condensation, vapor fractionation or selective volatilization of Fe, selective oxidation processes, selective shock-melting of sulphide-metal intergrowths at meteorite grain boundaries, ionic-radius-controlled mobility of certain elements [2]. One way to determine the relative importance of these different possible mechanisms this is to look at variations in other elements that have different behaviours during processes such as vaporization and oxidation. We are carrying out a petrographic, SEM, electron microprobe and LA-ICP-MS compositional study of individual metallic spherules from the Monturaqui impact crater to address these issues.

Background: The Monturaqui impact crater is in the Atacama Desert of northern Chile, 200 km SE of Antofagasta [4]. It is a simple, ~350 m diameter crater, emplaced into Paleozoic granite rocks that were covered by a thin ignimbrite sheet [5]. Its age is ~570-750 ka based on (U-Th)/He zircon/apatite, TL and cosmogenic nuclide methods [6,7]. The impactor is inferred to be a coarse octahedrite of group I based on intensely weathered fragments of iron meteorite ('iron shale') found in and around the crater. Centimetre-sized chunks of impact melt rocks occur scattered around the crater [1,4]. These rocks are comprised largely of glass melt and rock fragments that formed from melting of the granite and ignimbrite rocks present at the target site during the impact. Also present within the glass fragments are small droplets of Fe-Ni metal±sulphides (between < 1 µm and ~2 mm in size).

SEM study of impact melt fragments show that Fe-Ni±S spherules smaller than ~200µm (down to sub-µm) tend to be spherical in shape, while larger areas of Fe-Ni±S have complex irregular shapes, often with hollow centres. The smaller metal spherules are generally homogeneous w.r.t. Fe and Ni contents, with occassional interstitial troilite. The larger patches can show some zonation, typically with Ni-rich margins. The cores of several spherules have been variably replaced by barite during subsequent alteration.

EMP analysis of the glass shows enrichments of Fe w.r.t. target rocks, and significantly elevated S levels (1250±500 ppm), indicative of a S-rich iron meteorite component in the impact melt. However, fine, sub-micron spherules appear to be dispersed completely through the glass matrix, which makes it difficult to analyse metal-free patches of the impact glass by LA-ICP-MS (beam size > 10 µm) to evaluate this further.

Previous studies [1,2] showed significant compositional variations with spherule size: smaller spherules had higher Ni and Co and lower Fe and P relative to the larger spherules. New EMP analyses of spherules (n=100) confirm these variations (see figure), and show that the larger spherules have compositions similar to unaltered fragments of 'iron shale'. We are currently analysing these spherules for other trace elements (Ga, Ge, PGE etc) by LA-ICP-MS, and we will present these data at the meeting.



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