IRIDIUM METAL IN MELT ROCK FROM THE CHICXULUB IMPACT BASIN;
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We identified a ~4-μm-long, ~1 × 10⁻¹⁰ g “nugget” of Ir metal in a melt rock sample from the Chicxulub impact basin [1]. This particle, which consists of an aggregate of subhedral Ir metal grains surrounded by a thin coating of silicate (Fig. 1), was isolated in the course of our efforts to better understand the partitioning of projectile material between crater deposits and ejecta in large meteorite impact events. In addition to confirming earlier reports of Ir in melt rock and melt breccia within the K-T boundary source crater, the results of our search for physically identifiable carriers of meteoritic components provide additional evidence for extreme fractionation of siderophile elements and their concentration in sparsely disseminated trace phases [2-6].

Previous analyses showing elevated Ir [2,6], as well as the abundances and isotopic ratios of Os and Re [5], indicate the presence of a meteoritic component in some, but not all melt rock samples from Chicxulub. However, other siderophile elements (e.g., Co and Ni) appear to be decoupled from Ir [3,6]; this, and the failure to detect Ir enrichments in other samples from the same or adjacent core intervals [7-9] has led some to question the presence of a meteoritic signature at Chicxulub on both observational and theoretical grounds. With the exception of the ~100-km-diameter Popigai structure [10], melt rocks with Ir concentrations ≥1 ng/g are generally well known only from craters <25 km in diameter [11]. Theoretical models indicate that large, high-speed impactors essentially vaporize and escape from the crater as a hot gas [e.g., 12]. Consequently, one might not expect to find evidence of projectile components in a Chicxulub-class crater. Calls for cross-calibration of Ir analyses [9], and concerns of possible Au contamination expressed by Hildebrand et al. [7], add to the importance of the visual identification of siderophile element carriers in assessing the fate of the Chicxulub basin-forming meteorite.

Our initial characterization of drill core samples from two wells near the center of the Chicxulub basin, included instrumental neutron activation analyses (INAA) of ~50-100 mg splits from 12. ~0.5 g fragments that were powdered with a mortar and pestle [2,6]. Fragments of melt rock C1-N10-1 and melt breccia Y6-N19-R are among those in which Ir was detected. A ~60 mg split of remaining, unirradiated powder from each of these two samples was analyzed in a new INAA experiment, and then divided into five splits. The split with the highest Ir concentration was repeatedly subdivided, using the most Ir-rich of the successively smaller splits in each case. This procedure resulted in the isolation of single particles that contain the largest mass of Ir in each sample.

Figure 2 shows the results for Y6-N19-R, in which a particle containing ~2 × 10⁻¹⁰ g of Ir has been isolated, but remains to be identified. The most massive Ir-rich particle from C1-N10-1 (Fig. 1) was identified by scanning electron microscopy (SEM). Energy-dispersive X-ray spectra (EDS) indicate that the Ir is in the form of metal, and is not alloyed with any other platinum group elements (PGE) within EDS detection limits. The major element composition of the adhering silicate is similar to that of the bulk C1-N10-1 host rock. The subhedral form of the aggregate grains and the adhering silicate argue strongly against any conceivable anthropogenic contaminant.

In addition to being the first Ir carrier phase recognized at the K-T boundary, this particle appears to be the first example of naturally occurring pure Ir metal. Working hypotheses for the origin of the particle, although broad and necessarily speculative, include: (1) condensation from the impact vapor cloud, (2) formation during impact melt petrogenesis, and (3) incorporation of projectile material that survived complete vaporization. The presence of unalloyed Ir metal provides a first-order explanation for the previously noted decoupling of Ir from other siderophile elements among different melt rock samples, which can be accounted for in part by hydrothermal redistribution of Co and Ni [3,6]. However, analyses of two different samples from the C1-N10 core interval showed a correlation among Os, Re, and Ir concentrations [5]. This suggests not
only that the other PGE may also occur in micrometer-scale particles, but that these elements were included in larger masses of sparsely disseminated meteoritic material. To date, the only meteorites known to contain micrometer-size nuggets of highly fractionated PGE metals are C2 and C3 carbonaceous chondrites [e.g., 13].

Fig. 1. SEM photomicrograph of an Ir metal particle embedded in silicate material from the C1-N10-1 impact melt rock. Scale bar = 1 µm.

Fig. 2. Ir concentrations in successive subsplits of melt rock breccia sample Y6-N19-R. Diagonal lines trace the apparent Ir concentration as a function of subsplit mass resulting from the presence of a single, hypothetical sphere (or equivalent mass) of pure Ir metal (22.42 g cm⁻³) (respective particle diameters shown along upper abscissa). The intersection of any such line with any near vertical, volumetric isopleth delimits the nominal concentration of Ir included in a hypothetical, spherical host phase with an arbitrary density of 3.0 g cm⁻³.

REFERENCES