



LA-ICP-MS analysis of trace elements in glass spherules of the El'gygytgyn impact structure, Siberia

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The 3.58 ± 0.04 Ma old El'gygytgyn impact structure (Central Chukotka, NE Siberia) with a diameter of 18 km (Gurov and Gurova 1979, Lauer 2000) is one of only two terrestrial craters with a volcanic target; therefore, analysis of its target and impact lithologies is of basic interest for comparative planetology. Lake El'gygytgyn is a very valuable climate archive in the Arctic as it was neither covered by glaciers (Melles et al. 2007) nor has the lake ever fallen dry. Climate and impact research were the rationale for the ICDP drilling project that finished successfully in spring 2009. Impactites like melt rocks and breccias are rarely found in outcrops yet are present in the 80 m terrace of Lake El'gygytgyn (Gurov and Gurova 1979). Numerous investigations on petrography, shock metamorphism, and geochemistry of impactites from El'gygytgyn have been published so far (e.g. Gurov et al. 2007). We report the first trace element data for seven 30- to 760- μm -sized impact glass spherules that have been collected about 10 km off the crater center from a terrace deposit of the Enmyvaam River outside the crater rim. The spherules are translucent with colors ranging from amber, dark brown to nearly black; they contain a few circular bubbles, schlieren, and very rarely mineral clasts and breccia fragments. Major elements were measured with the JEOL JXA 8600 MX Superprobe, 31 trace elements were analyzed with the Finnigan Element2 LA-ICP-MS with 5 Hz, 8–9 J/cm² at with Si as internal, and NIST612 as external standard (Institut f. Mineralogie, WWU Münster). The spot size was 60 μm . All spherules show a very homogeneous major and trace element distribution yet clear differences exist between the samples in the SiO₂ content (in weight percent) 53–68: four of the glasses are dacitic, two andesitic, and one basaltic-andesitic in composition. In addition, MgO (2.1–9.2), K₂O (0.6–3.3), and (in ppm) Ni (317–1096), Co (25–79), Zr (100–169), Rb (18–107), and Ba (459–1092) display wide ranges in concentration. The Ni/Co ratio is consistently high (11–14), the Zr/Hf ratio range between 36 and an anomalous high value of about 50, the Nb/Ta ratio vary from 17.6 to 14.9. The rare earth element distribution patterns are similar, yet samples with low SiO₂ contents (53.1–58.4) have lower REE concentrations except for Eu. The new trace element data for impact glass lithologies from El'gygytgyn extent the range of known impactites (Gurov et al. 2007) into the field of more mafic compositions. Basalts to andesites are known to occur in the El'gygytgyn area, and obviously form the precursor lithologies for two of the spherules. All impact glass samples plot in the Zr-Ti-Y-diagram (in the tectonic setting for calc-alkaline rocks, as expected from the larger geological frame (Chekhovich et al. 1999), indicating that impact melting did not change the primary characteristics of the precursor rocks. In agreement with this setting are the Nb/Ta and Zr/Hf values although a Zr/Hf of 50 is remarkable. Origin and importance of the exceptional high Ni contents, in combination with high Ni/Co ratios are currently not understood. We exclude, however, technical reasons for these data as analyses of standard glass NIST 612 measured as unknown yielded satisfactory results.