THE FRACTIONATION OF OS, RE, IR, RU, RH, PD AND AU IN IMPACT MELTS FROM EUROPEAN IMPACT CRATERS (SÄÄKSJÄRVI, MIEN AND DELLEN) AND THE DETERMINATION OF THE METEORITIC COMPONENTS

G. Schmidt[1], H. Palme[2] and K.-L. Kratz[1], [1]Institut für Kernchemie, Johannes Gutenberg-Universität Mainz, Fritz-Straßmann-Weg 2, D-55099 Mainz, Germany; [2]Mineralogisch-Petrographisches Institut, Universität zu Köln, Zülpicher Straße 49b, D-50674 Köln, Germany.

Lunar highland rocks contain an excess of siderophile elements, which has been attributed to meteoritic influx after the formation of the lunar crust [1,2,3,4]. Siderophile element enrichment has subsequently become a standard method for the identification of terrestrial impact craters. Janssens et al. [5], Grieve [6] and Palme et al. [7] have shown the dominant role of impact melt as the main carrier of meteoritic material at large terrestrial impact craters. Coherent melt sheets always have the highest concentrations of siderophile elements. This has been observed at Clearwater East (Palme et al. [8]), Lappajärvi (Reimold and Stöffler [9]; Reimold [10], Göbel et al. [11]), Sääksjärvi (Palme et al. [12]), Brent (Grieve, [6]) and Rochechouart (Janssens et al. [5]). The amount of projectile material incorporated in impact melt sheets is generally low (<1%). The highest recorded is 10% at East Clearwater, where the siderophiles are carried in a sulphide phase. In other cases, searches for siderophile anomalies at some impact structures have been largely unsuccessful. Melt bearing mixed breccias (suevitic melt) and fall-back sediments have been found to be free of meteoritic components in Brent, Lappajärvi and Ries samples (Grieve [6]; Reimold and Stöffler [9]; Morgan et al. [12]; Schmidt and Pernicka [13,14]). This may be due to a variety of reasons, including: (i) a sampling problem; (ii) the impact of a differentiated projectile with little or no siderophile element enrichment with respect to terrestrial materials, (iii) or uncertainties in making corrections for indigenous siderophile elements. However, from approximately 130 craters which are currently known on Earth only four clearly identified chondrites have been found as projectiles of large craters [15,16].

Based on Ir, Au, Ni, Co and Cr data from small samples (100-200 mg), Palme et al. [7] concluded that there is a meteoritic contribution in the impact melt of Sääksjärvi, Mien and Dellen. They found in five samples from Sääksjärvi fairly homogeneously distributed meteoritic components (Ir concentrations are 3.6 to 5.5 ng/g), within the melt sheet with Ni/Ir ratios significantly higher than any chondritic ratio. From Mien and Dellen so far only one sample from each melt has been analyzed; both contain about 1 ng/g Ir.

In this studie we analyzed large whole rock samples (10 g) from all three craters to avoid inhomogeneity of small samples in which indigenous siderophiles, especially PGEs can be very locally enriched (nugget effects). Twentytwo samples were obtained from the collection of the University of Münster. Only fresh, nearly fragment-free, fine grained samples without any sign of alteration were selected for chemical studies. All samples have been described previously by Maerz [17]. Whole rock samples were sawn into 100 g pieces with a diamond saw. After crushing with a hammer, wrapped in polyethylene, samples were ground in an agate mill. Aliquots of 10 g (<50 μm) of the homogenized samples were used for analysis. Altogether twentytwo impact melt samples have been analyzed for PGEs, Re and Au by a slightly modified version of the fire assay neutron activation method using nickel sulphide as the collector [14]. These authors also showed that Re is extracted with PGEs into NiS, allowing the determination of Re together with PGE in a single sample [13,14]. The INAA procedure involved two irradiations: a short irradiation for Rh and a long irradiation for the other elements.

Impact melts from Sääksjärvi are highly enriched in PGEs. The flat siderophile pattern suggests that the meteoritic component (PGE/CI = 3×10^{-3} to 9×10^{-3} relative to CI) in the Sääksjärvi impact melt is relatively unfractionated. Stony-iron meteorites (pallasites) as proposed earlier [7] can therefore be excluded as possible contaminants because members of this group have higher than chondritic Pd/Ir ratios. Impact melts from Mien and Dellen are moderately enriched in PGE. The concentrations are similar (PGE/CI = 3×10^{-4} to 1×10^{-3} relative to CI). The flat siderophile pattern of the Mien and Dellen impact samples are compatible with carbonaceous chondrite type of material, but a clear geochemical association of any of the known meteorite types is not possible because of the low signal-to-background ratio for Rh, Ru, Pd, and Au.

Samples from all impact craters have low Os/PGE ratios compared to chondritic ratios. It seems that the oxygen fugacity at the time of impact melting, vaporization and crystallization of the melt body may play the dominant role in the fractionation of Os and PGEs. If Os have been lost by volatilization of OsO_4 under oxidizing conditions, than Ir is the only element to confirm meteoritic enrichments down to a level of 2×10^{-4} CI chondrite. None of the other elements determined are sufficiently sensitive indicators to confirm small meteoritic enrichments, equivalent to $<10^{-3}$ CI chondrite, because of low CI/Earth crust-ratios.

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