PLATINUM-GROUP ELEMENT AND RHENIUM–OSMIUM GEOCHEMISTRY OF SELECTED CARBONATITES FROM INDIA, USA AND EAST AFRICA

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Carbonatites and associated alkaline silicate rocks might represent potentional economic source for a large variety of metals such as Cu and platinum-group elements (PGE – Os, Ir, Ru, Pd, Pt) as it is demonstrated in Phalaborwa (South Africa) [1] or Ipanema (Brazil) [1]. In addition, determined PGE contents along with Re–Os isotopic compositions may also provide important informations about PGE fractionation during the genesis of upper mantle-derived carbonatitic melts and nature of their sources. Nevertheless, the existing PGE data for carbonatites are extremely rare, limited mostly to Chinese localities and they are not paralleled by Re-Os isotopic data [3]. Therefore, in this study, we present the first complete PGE datasets together with Re-Os determinations for a suite of selected carbonatite bodies worldwide.

We have chosen eight carbonatite sites with different alkaline rock association, age and geotectonic position. Among these, the youngest samples are from East African rift system and include Oldoinyo Dili, Tanzania with an age spanning from ~0 to 45 Ma; same as Tororo and Sukulu in Uganda [4]. These carbonatites are in association with pyroxenites and nepheline syenites. Another young carbonatitic complex is Amba Dongar with Cretaceous age of ~65 Ma associated with alkaline volcanic rocks such as trachybasalts within Deccan Traps [5]. Proterozoic bodies are represented by Iron Hill, USA carbonatites associated with pyroxenite, melitolite and ijolite with age ranging from ~520 to 580 Ma [6]. These carbonatites are famous for their intensive and varied fenitization. Last and the oldest carbonatites in this study comes from Samalpatti and Sevattur, S India having the age of ~ 800 Ma [7] and outcropping as small bodies within alkaline rocks such as pyroxenite, syenite and gabbro.

The PGE concentrations and Re–Os isotopic ratios were determined by standard methods consisting of decarbonatization using HCl, decomposition of samples in Carius Tubes in the presence of spikes (isotopic dilution), separation of Os by $CHCl_3$ followed by N-TIMS measurements and Ir, Ru, Pd, Pt, Re isolation by anion exchange chromatography followed by ICP-MS measurements.

In overall, all analysed carbonatites exhibit extremely low PGE contents (∑ PGE up to 1 ppb), even in the samples with high S contents (up to 1.5 wt. %). Such values are much lower than other determined so far for upper mantle-derived melts such as basalts, komatiites etc. [8]. Such signatures indicate very low partitioning of PGE into carbonatitic melts and/or early separation of PGE-bearing fraction. Elements from iridium-group (I-PGE; Os, Ir and Ru; mostly < 0.1 ppb) are distinctly lower compared to palladium-group elements and Re (P-PGE; Pt, Pd, Re; mostly > 0.1 ppb) with some rocks being largely enriched in Re (up to ~6 ppb). Most of the analysed carbonatites exhibit progressive enrichment from Os to Re and consequently, Pd_N/Re_N < 0.1 except south India carbonatites and associated alkaline rocks (>0.30). Rocks analysed so far for Os have Os_N/Ir_N up to 6.2 that might suggest that the carbonatites might concentrate Os over Ir. The highest HSE_{tot} contents have been been found in Mg-Cr-rich silicocarbonatites from South India (up to 40 ppb) and taking into account their only slightly radiogenic $^{187}Os/^{188}Os$ ratios (0.14–0.57), these rocks represent a mixture of CO_2-rich alkaline mantle melts and country rocks. Very high concentrations of HSE have been also found in magnetite separated from Fe-carbonatite from Ambadongar, India (0.2–0.5 ppb of I-PGE and 0.9–9 ppb of P-PGE). The $^{187}Os/^{188}Os$ ratios determined so far for carbonatites from South India vary from 0.24 to 6.5 and calculated γOs values range from +100 up to +5000. Such wide range of values suggest extremely heterogenous source of the melts and/or possible contamination by ^{187}Os-rich crustal materials.

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