DIAMONDS FROM THE KIMBERLITES OF SOUTHEASTERN RAIPUR KIMBERLITE FIELD, RAIPUR DISTRICT, MADHYA PRADESH, CENTRAL INDIA

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The Occurrences

Three diamond bearing kimberlites viz., Payalikhand - I, Payalikhand II and Bahradih and numerous non-diamondiferous ones have been located since 1988 in the Southeastern Raipur Kimberlitic Field (SRKF), in the Raipur District of the state of Madhya Pradesh in Central India (Chatterjee et al., 1995). This is a breakthrough discovery in the Central part of peninsular India known for many centuries for its alluvial diamonds from the gravels of the Mahanadi river valley. While, both diatreme and hypabyssal facies kimberlitic rocks occur in SRKF, the only diamondiferous ones are certain of the diatreme facies occurrences. Most of the kimberlitic pipes have been eroded by at least some 150 to 300 m since emplacement. Diamonds have also been recovered from secondary sources, some of which can be traced to individual kimberlitic bodies in the SRKF. Every known diamond occurrence is being exploited by local diggers who are working both the colluvial scree, which overlies the pipes, and the nearby stream gravels.

The Diamonds

Diamonds from all the sources in the SRKF strongly resemble each other, varying from clear white gems to light yellow to grey, to intensely brown, sometimes rich in graphite inclusions. No bulk sampling has been done yet, but local diggings indicate that approximately 30% to 50% of the diamonds are gem quality. Morphologically, both regular planar octahedrons and more resorbed octahedra-dodecahedra curved forms occur. Macles and aggregates are common. Transparent macro diamonds are more numerous than frosted-surface ones. Lots of diamonds show etch channels. More than 10% of the diamonds recovered by the local diggers are greater than 1 ct in weight, the largest reportedly recovered from the area by the locals being up to 202 ct.

Microdiamonds recovered from the kimberlites show less resorption and are predominately white or occasionally brown, clear, planar octahedra, aggregates and irregular shapes, with common step-layered growth habit. Most of them contain black inclusions, probably graphite. Surface features show light to medium frosting with occasional striations and other signs of partial resportion on the larger stones.

Detailed Diamond Studies

A suite of 18 macrodiamonds from Payalikhand (11) and Bahradih (7) have been examined in detail. All are brown rounded dodecahedra, apart from one partially resorbed octahedron. Most show slight aggregation and more thanhalf are macled. Glide planes and fractures are abundant. Black inclusions (?graphite), and less common silicate inclusions are present. The suite range from 0.16 to 4.58 ct. Windows have been polished into 21 of the suite to expose inclusions and allow FT-IR and cathodoluminescence (CL) study.

Initial FT-IR measurements (collected and processed using the methods described by Taylor et al., 1990) from 10 of the Raipur stones show 1aA-1aB spectral characteristics with low aggregation, usually around 5% 1aB and up to 23%. There is considerable variation in nitrogen (128 - 1778 ppm) and relative hydrogen (low-medium) content both between and within stones. Assuming kimberlite emplacement around 0.8 Ga (Chatterjee et al., 1995) and diamond formation around 3.2 Ga the FT-IR data gives residence temperatures tightly clustered around 1080°C, excepting one stone at 1159 deg.C (for a 2.7 Ga growth event the temperature data increases by only 6 deg.C).

Flood CL images of the Raipur stones are weakly to moderately pale blue and show faint zoning. A small proportion show faint, pale yellow deformation lamellae overprinting the primary growth zoning.

Graphite spots form the most common inclusions in SRKF diamonds. The xenocrystic population from SRKF kimberlite concentrates are dominated by a peridotitic mineral assemblage, including diamond inclusion-type harzburgitic pyropes and chromites. However, mineral inclusion analyses from the studied diamond suite indicate the presence of both syngenetic eclogitic and peridotitic varieties. The peridotitic suite (2 diamonds) is represented by olivine inclusions which are strongly forsteritic (Fo 0.87 to 0.91).

The eclogitic suite (1 diamond) is represented by pyrope - almandine garnet inclusions having affinity with cluster group 3 of Dawson and Stephens (1975) based on their MgO, FeO, and CaO contents, but also showing affinity with group 4 because of high TiO_2 levels (0.72 to 0.88%). Two other diamonds contain K-feldspar inclusions, mostly irregular in shape; whether this feldspar is of primary or secondary origin is uncertain at this stage, but sanidine is classified by Meyer (1987) as a primary inclusion of eclogitic paragenesis.

Discussion

SRKF diamonds thus show features similar to diamonds from kimberlites from other parts of the world. The degree of resorption apparent in the macrodiamond population is not paralleled in the microdiamonds which are predominately primary planar primary octahedrons, a relationship often seen in other diamond occurrences (e.g. Ellendale lamproites, Western Australia - Hall and Smith, 1985). Both eclogitic and peridotitic inclusion assemblages are present.

The average mantle residence temperature of around 1080°C derived from the FTIR measurements, when taken together with the relatively low amount of aggregation considering the reasonable amount of nitrogen in the diamonds, may well suggest a cold cratonic geotherm setting and is in keeping with local heat flow measurements today of 40mW/m^2 (Chatterjee et al., 1995).

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