Superdeep diamonds from the Juina area, Mato Grosso State, Brazil

Received: 29 May 2000 / Accepted: 30 October 2000 / Published online: 9 February 2001
© Springer-Verlag 2001

Abstract Alluvial diamonds from the Juina area in Mato Grosso, Brazil, have been characterized in terms of their morphology, syngenetic mineral inclusions, carbon isotopes and nitrogen contents. Morphologically, they are similar to other Brazilian diamonds, showing a strong predominance of rounded dodecahedral crystals. However, other characteristics of the Juina diamonds make them unique. The inclusion parageneses of Juina diamonds are dominated by ultra-high-pressure ("superdeep") phases that differ both from "traditional" syngenetic minerals associated with diamonds and, in detail, from most other superdeep assemblages. Ferropericlase is the dominant inclusion in the Juina diamonds. It coexists with ilmenite, Cr-Ti spinel, a phase with the major-element composition of olivine, and SiO₂. CaSi-perovskite inclusions coexist with titaneite (sphene), "olivine" and native Ni. MgSi-perovskite coexists with TAPP (tetragonal almandine-pyrope phase). Majoritic garnet occurs in one diamond, associated with CaTi-perovskite, Mn-ilmenite and an unidentified Si-Mg phase. Neither Cr-pyrope nor Mg-ehromite was found as inclusions. The spinel inclusions are low in Cr and Mg, and high in Ti (Cr₂O₃ < 36.5 wt%, and TiO₂ > 10 wt%). Most ilmenite inclusions have low MgO contents, and some have very high (up to 11.5 wt%) MnO contents. The rare "olivine" inclusions coexisting with ferropericlase have low Mg# (87–89), and higher Ca, Cr and Zn contents than typical diamond-inclusion olivines. They are interpreted as inverted from spinel-structured (Mg, Fe)₂Si₂O₄. This suite of inclusions is consistent with derivation of most of the diamonds from depths near 670 km, and adds ilmenite and relatively low-Cr, high-Ti spinel to the known phases of the superdeep paragenesis. Diamonds from the Juina area are characterized by a narrow range of carbon isotopic composition (δ¹³C = -7.8 to -2.5‰), except for the one majorite-bearing diamond (δ¹³C = -11.4‰). There are high proportions of nitrogen-free and low-nitrogen diamonds, and the aggregated B center is predominant in nitrogen-containing diamonds. These observations have practical consequences for diamond exploration: Low-Mg olivine, low-Mg and high-Mn ilmenite, and low-Cr spinel should be included in the list of diamond indicator minerals, and the role of high-Cr, low-Ti spinel as the only spinel associated with diamond, and hence as a criterion of diamond grade in kimberlites, should be reconsidered.

Introduction

The Juina area is a major diamond mining area in Brazil (Fig. 1). In the late 1980s–early 1990s, as many as 50,000 artisanal miners (garimpeiros) worked this area, producing up to 5–6 million carats of diamonds each year according to local sources of information. Many of the diamonds recovered during this period were larger than 100–200 carats, with the largest reported stone weighing up to 480 ct (Gaspar et al. 1998). There are at least 26 kimberlite pipes in the area. Some of them are sub-economic with up to 0.5 ct t⁻¹ diamond grade. However, all diamond production has been from recent alluvial and colluvial deposits.
Fig. 1 Location and sketch map of the Juina area. Black circles Diamond sample sites; black diamonds finds of large diamonds (in carats); shaded area Cretaceous-Tertiary “Chapada” deposits.

Diamonds from this area have attracted considerable attention because several studies by J.W. Harris, B. Harte and coworkers (summarized by Harte et al. 1999) have documented the presence, in diamonds from the Sao Luiz drainage, of a mineral inclusion paragenesis that suggests derivation from the lower mantle at depths of at least 660 km.

We have studied a set of 475 diamonds, from 0.01–5.3 ct in weight, from several drainages within the Juina area (Fig. 1). These include the Rio Sao Luiz [sample