

## Low-temperature Pt–Pd mineralisation: Examples from Brazil

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Hematite-bearing Au–Pd mineralisation in Brazil commonly has a platiniferous component [1, 2]. Examples are Hg-bearing hongshiite, PtCu, and Pt<sub>2</sub>HgSe<sub>3</sub>, both from Itabira, Minas Gerais. These minerals occur in specular hematite-rich veins that cross-cut the ~0.6-Ga Brasiliano tectonic foliation of the host rock (itabirite). This vein mineralisation is called ‘jacutinga’. The presence of barite in hongshiite and Na/K–Na/Li fluid–mineral geothermometers indicate that oxidising brines of evaporitic origin were instrumental to the Au–Pd–Pt mineralisation at a maximum temperature of about 350°C [3].

Platiniferous alluvia are found in the quartzitic domains of the Palaeo-Mesoproterozoic southern Serra do Espinhaço, Minas Gerais, north of Itabira. Alluvial palladiferous gold and specular hematite point to ‘jacutinga’-like veins in the quartzite country rock in the Córrego Bom Sucesso area. We found high Pd/Ag ratios (~4–3700) in the alluvial palladiferous gold. Such ratios are thermodynamically restricted to very oxidising brines [4]. In addition, Córrego Bom Sucesso is famous for its botryoidal Pt–Pd aggregates, reaching several millimetres across, which formed within the alluvium [1, 2, 5].

In northern Brazil, Au–Pd–Pt bonanza mineralisation triggered the gold rush that made Serra Pelada known worldwide. The near-surface mineralisation is hosted by weakly metamorphosed metasedimentary rocks of supposedly Neoproterozoic age, but the bonanza ore is coeval with a Mn–Ba oxide, which has a Late Cretaceous <sup>40</sup>Ar/<sup>39</sup>Ar age [6]. Fluid-inclusion microthermometric data from quartz and the mineral assemblage of Mn–Ba oxide and fine-grained specular hematite give evidence for very oxidising brines at temperatures between ~100 and 170°C.

[1] Hussak (1904) *Sitz.-Ber. math.-naturwiss. Kl. Kais. Akad. Wiss.* **113**, 379–466. [2] Cabral *et al.* (2009) *Econ. Geol.* **104**, 1265–1276. [3] Lüders *et al.* (2005) *Miner. Deposita* **40**, 289–306. [4] Gammons *et al.* (1993) *Geochim. Cosmochim. Acta* **57**, 2469–2479. [5] Cabral *et al.* (2011) *Chem. Geol.* **281**, 125–132. [6] Cabral *et al.* (2011) *Econ. Geol.* **106**, 119–125.

## Iodine fingerprints biogenic fixation of platinum and palladium

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Botryoidal aggregates of platinum (Pt) and palladium (Pd) from an alluvial deposit (Córrego Bom Sucesso) in Serra, Minas Gerais, Brazil, were likely the sample material from which Wollaston [1] isolated and identified Pd for the first time [2]. We recovered millimetre-sized botryoidal and rod-shaped grains of Pt and Pd from the alluvial deposit. Their arborescent morphologies indicate that the Pt–Pd aggregates formed *in situ* within the alluvium [2]. We carried out synchrotron radiation-induced X-ray fluorescence (SR-XRF) spectrometry on the Pt–Pd aggregates to determine iodine. We found high concentrations of iodine, in the range from 10 to ~120 µg/g [3]. Iodine is a strongly biophile element [4], which is enriched in peatlands by microbial activity [5]. Its high concentration in the Pt–Pd nuggets suggests that microbial activity took place during precious-metal fixation in the aqueous alluvial milieu. The Pt–Pd nuggets have an average thallium/selenium ratio of about 0.08, a value close to that for fluvial waters, suggesting that Pt and Pd were fixed from highly dilute solutions within the alluvium [6]. Inorganic and biogenic processes, i.e. electrochemical metal accretion [7] and bioreduction, are thought to have contributed to the growth of biogenic Pt–Pd nanoparticles that formed on organic templates such as humified plant remains.

[1] Wollaston (1809) *Phil. Trans.* **99**, 189–194. [2] Hussak (1906) *Z. prakt. Geol.* **14**, 284–93. [3] Cabral *et al.* (2011) *Chem. Geol.* **281**, 125–132. [4] Goldschmidt (1958) *Geochemistry*. Oxford University Press. [5] Keppler *et al.* (2004) *Environ. Chem. Lett.* **1**, 219–223. [6] Cabral *et al.* (2009) *Econ. Geol.* **104**, 1265–1276. [7] Cabral *et al.* (2009) *Eur. J. Mineral.* **21**, 811–816.