The Pimenta Bueno Kimberlite Field, Rôndonia, Brazil: evidence for tuffisitic kimberlite

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Introduction: Kimberlites were emplaced across the South American Platform in Brazil during the Mesozoic. The Pimenta Bueno kimberlite field occurs in western Brazil in the state of Rondônia (Fig. 1). This field includes 33 kimberlite bodies, 15 of which are diamond-bearing. Rio Tinto Desenvolvimentos Minerais Ltda. (RTDM) and their joint venture partner Vaaldiam Resources Ltd. are evaluating nine bodies. Preliminary results of the investigation of the geology 2005 drillcores are presented below.

Geological Setting: The Pimenta Bueno region lies within the Amazon Proterozoic Craton of the South American Platform. The basement is composed of metamorphic and igneous rocks. Repeated movements on major ancient faults opened rifts following Rodinia breakup (≈1.0-0.75Ga). This led to wide intracratonic basins which accumulated thick sedimentary sequences from the early Silurian to the Permian. Most of the Pimenta Bueno kimberlites are located within the Pimenta Bueno fault graben which is infilled with Paleozoic sediments. Other kimberlites occur within basement outside the graben.

Rock-Type Classification: The rocks are characterized by macrocrystic textures (Figs. 3 and 4). Anhedral olivine macrocrysts (generally <5mm, up to >10mm) are common. Other mantle-derived xenocrysts include ilmenite and less garnet, both with compositions typical of kimberlites. Finer-grained olivine occurs as subhedral to euhedral primary phenocrysts (generally <0.5mm, rarely up to 2mm). Fresh olivine is not observed. Groundmass minerals in the magmatic rocks include spinel, perovskite, phlogopite, apatite and probable primary carbonate and serpentine. The Pimenta Bueno rocks can be classified as kimberlite (sensu stricto). Similar features occur in the magmaclastic rocks.

Body Shape and Size: The nine Pimenta Bueno kimberlite bodies being evaluated include seven steep-sided pipes (Fig. 2) with circular plan view shapes and areas ranging up to >15 ha. which were emplaced into sediments within the Pimenta Bueno graben. Limited information suggests that two other small bodies are flat-lying tabular sills up to 1-2m thick. The latter bodies are composed of magmatic kimberlite. The pipes are composed of varied, often xenolith-rich and/or magmaclastic, kimberlite. The geology of these bodies is discussed below focusing on three pipes (Cosmos 1, Pepper 4, Pepper 13) and one sill (Pepper 6). Figure 1 shows the location of these bodies.

Age of Intrusion: A late-middle Triassic emplacement age of 226.6±7.2 Ma. has been determined for Cosmos-01 using Rb-Sr methods on phlogopite (R. Creaser, University of Alberta, 2006).

Main Kimberlite Textural Types (Figs. 3 and 4; terminology after Field and Scott Smith 1998): The four bodies are composed of kimberlite with three main textural end members: (i) magmatic kimberlite, (ii) magmaclastic kimberlite, (iii) xenolith-rich magmaclastic kimberlite. Rock **type (i)** is described in the Rock-Type Classification above: macrocrystic hypabyssal kimberlite (HK). Rock **type (ii)** comprises medium grey coloured rocks which contain some angular, locally derived sedimentary xenoliths and common olivine pseudomorphs set in a lightish coloured matrix. Open and/or matrix supported textures are common. Most of the xenoliths and olivine grains are rimmed by thin, cryptocrystalline, often optically irresolvable, selvages of kimberlite and thus comprise magmaclasts. Examination of the selvages of kimberlite using SEM-BSE methods (Fig. 4, PP04-01 64.8m), shows that they are composed of diopside, chloritized mica and apatite (R.H. Mitchell, unpublished report, 2005). The magmaclasts are pelletal lapilli. The inter-lapilli matrix is composed of patches of material similar to the rims as well as microlites, widely scattered single crystals of altered perovskite and rare spinel in a base of serpentine. The rock has an overall brown colour in thin section. Carbonate is absent. The observed features are diagnostic and show that these rocks can be classified as macrocrystic tuffisitic kimberlite (TK) or tuffisitic kimberlite breccia (TKB if ≥15vol% xenoliths >1cm in size). Rock **type (iii)** contains more common xenoliths (up to >75%), xenocrysts of quartz, feldspar and mica derived from the sedimentary country rock, common olivine and other mantled-derived xenocrysts set in a brown-red matrix. The olivine grains often have thin selvages and thus resemble the pelletal lapilli in the TK. This material is separated from TK or rock type (ii) based on the abundance of xenoliths, close packed textures, sub-horizontal fabrics, olivine and xenolith sorting, grading, overall colour and alteration and it is termed volcaniclastic kimberlite breccia (VKB). With depth, the increasing proportions of kimberlite over xenolithic material, kimberlite selvages on xenoliths and microlitic textures in the matrix suggest that this rock type may include resedimented material (VKB) overlying pyroclastic kimberlite (VK). VK can also grade into TK. In some cases, TK grades with depth into HK. Based on 1-3 drillcores per body, the kimberlite textures of the four selected bodies (Fig. 1) are described below (terminology after Hetman et al. 2004).

Pepper 6: The sill occurs ~25m from surface and is ~1-2m thick. It is composed of carbonatized sparsely-to-moderately macrocrystic HK with a groundmass that appears to be well crystallized (spinel/perovskite up to 0.1mm). Segregationary textures result from irregular pools of carbonate and isotropic serpentine. A few elongate local sedimentary xenoliths are aligned and flow zoning may be present.

Cosmos 1: This 2.5 ha. pipe is infilled with overall massive uniform grey TK (Fig. 3 PPDD001) which has been identified in three drillcores to ~200m from surface. Below 100m, however, the kimberlite is somewhat different. Small darker more magmatic textured areas become macroscopically more common with depth. In addition the degree of xenolith digestion increases and below 150m only relicts are evident. Also some, but not all, of the samples display microscopic TKt textures where the pelletal lapilli are not fully developed. This suggests that below ~100m is a textural transition including some TKt.

Pepper 4: Red-grey VKB (Figs. 2 and 3, PP04-01 33.75m) infills the upper part of this 7 ha. pipe. It is composed of closely packed pelletal lapilli, common country rock xenoliths and xenocrystic quartz. This rock type resembles resedimented material. With depth there are less xenoliths, and the rock is termed VK (Fig. 3, PP04-06 98.7m). Below ~100m from the surface the kimberlite appears to grade into grey TK (Fig. 3, PP04-06, 113.55m).

Pepper 13: The upper part of the 1.5ha. pipe is composed of TK (Fig. 2). In hole PP13-01 diffuse megascopic textural changes together with the petrography of samples suggests that above 81.3m is light grey TK, below that is light to medium grey TKt, below 116.9m is darker grey HKt and below 138.8m is dark grey HK. The area between 81.3-138.8m thus appears to be a textural transition from TK to HK (Figs. 3 and 4).

Other Pimenta Bueno bodies: Probable TK has been observed in three of the four other larger (>2 ha.) pipes including Pepper 3 which is >15 ha.. VKB overlies TK in the four bodies >5 ha. and a kimberlite-poor breccia overlies the VKB only in the largest pipe, Pepper 3.

CONCLUSIONS: The Pimenta Bueno kimberlite field includes both pipes which range from 2 to >15 ha. in size and a few apparently flat-lying hypabyssal kimberlite sills. All but one of the pipes contain tuffisitic kimberlite (TK) which has striking similarities to that of many kimberlites of southern Africa and the Gahcho Kué pipes, NWT in Canada. Classic TK in steep-sided pipes can be termed diatreme-facies kimberlites. The association of TK with HK in both sills and the deeper parts of the pipes as well as overlying VK is also comparable to many southern Africa and the Gahcho Kué fields. The Pimenta Bueno kimberlite field thus represents a newly recognized example of southern African style-kimberlite pipes occurring on a third continent. The Pimenta Bueno, southern Africa and Gahcho Kué kimberlites are markedly different from other provinces such as those found in the Canadian Prairies and Lac de Gras, NWT. This shows that pipes containing TK and related textures are repeated in space and time but only form in certain circumstances. Although the information is preliminary, there is a correlation between kimberlite texture and pipe size. In the larger pipes >5 ha., the TK is overlain by VKB. In the small pipes <3 ha. there is a textural gradation with depth from TK to HK similar to that described by Hetman et al. (2004). One TK-HK transition appears to be ~60m thick. The nature of the TK-HK textural transition suggests that TK developed by the textural modification of magmatic kimberlite (or HK).

References

Field M., Scott Smith B. H. 1998. Textural and genetic classification of kimberlites: a new perspective. Extended Abstracts of the 7th International Kimberlite Conference, Cape Town, South Africa, p. 214-216.

Hetman, C. M., Scott Smith, B. H., Paul, J. L., Winter, F. 2004. Geology of the Gahcho Kué kimberlite pipes, NWT, Canada: root to diatreme magmatic transitions zones. Lithos 76, p. 51-74.

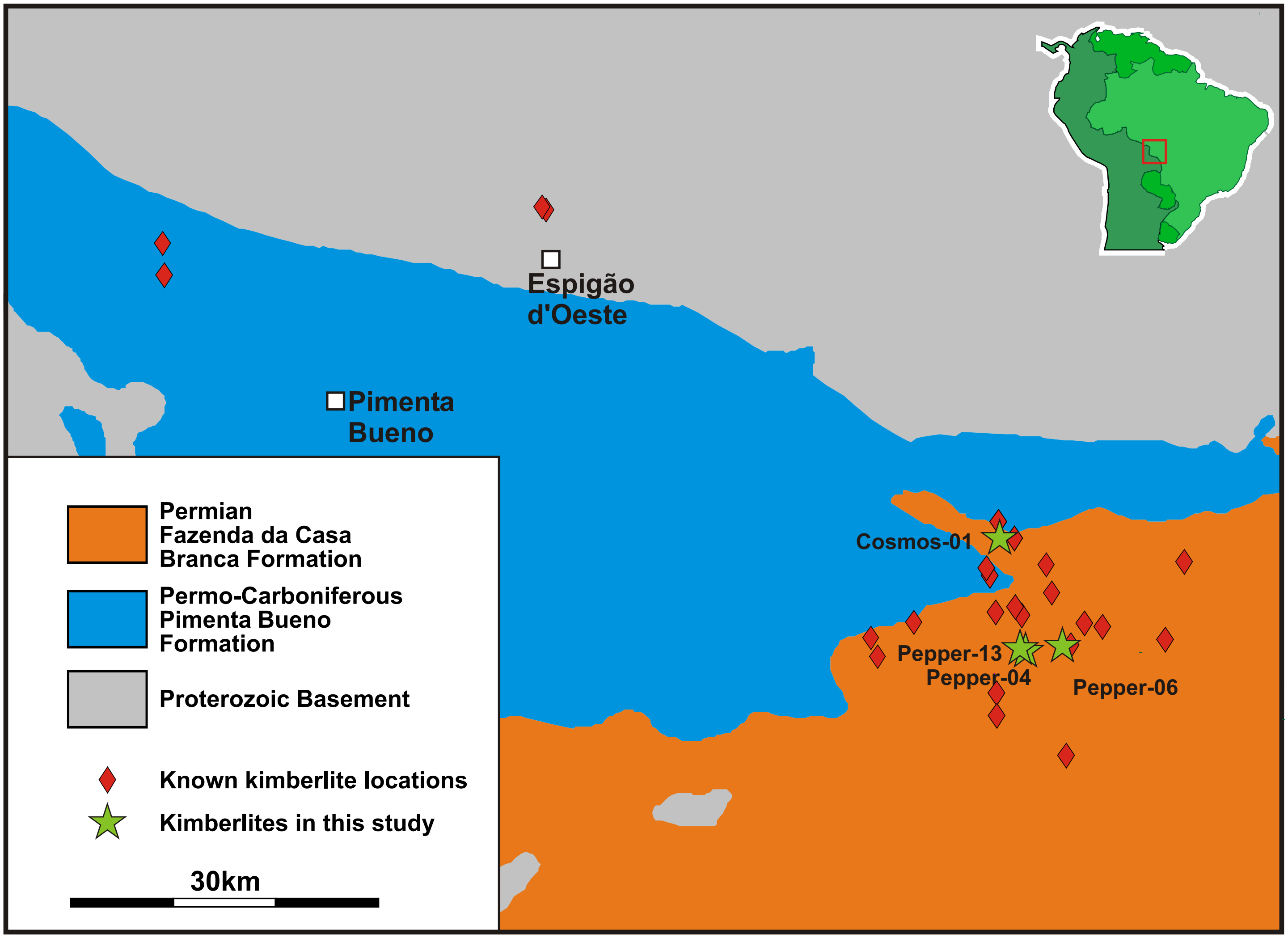

Fig. 1 Location and geological setting of the Pimenta Bueno kimberlite field. This study investigates the four labeled bodies.

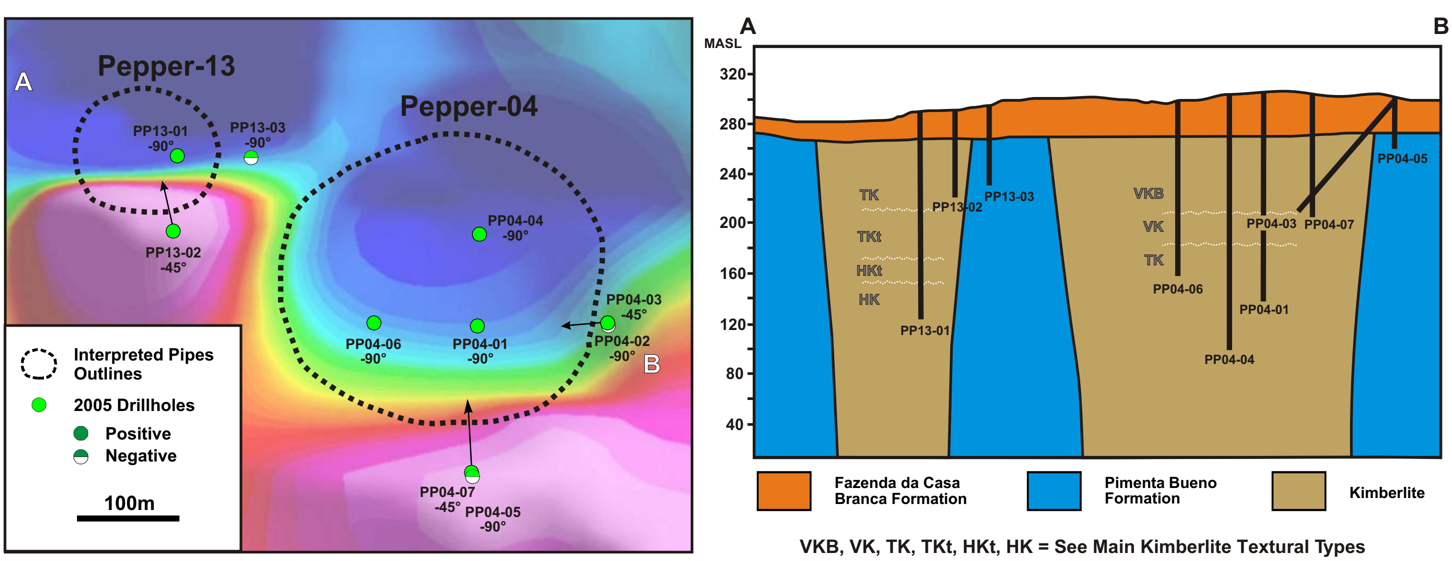

Fig. 2 Plan view with ground magnetics and schematic cross-section of the Pepper-13 and Pepper-04 kimberlites summarizing the textures observed in drillcore.

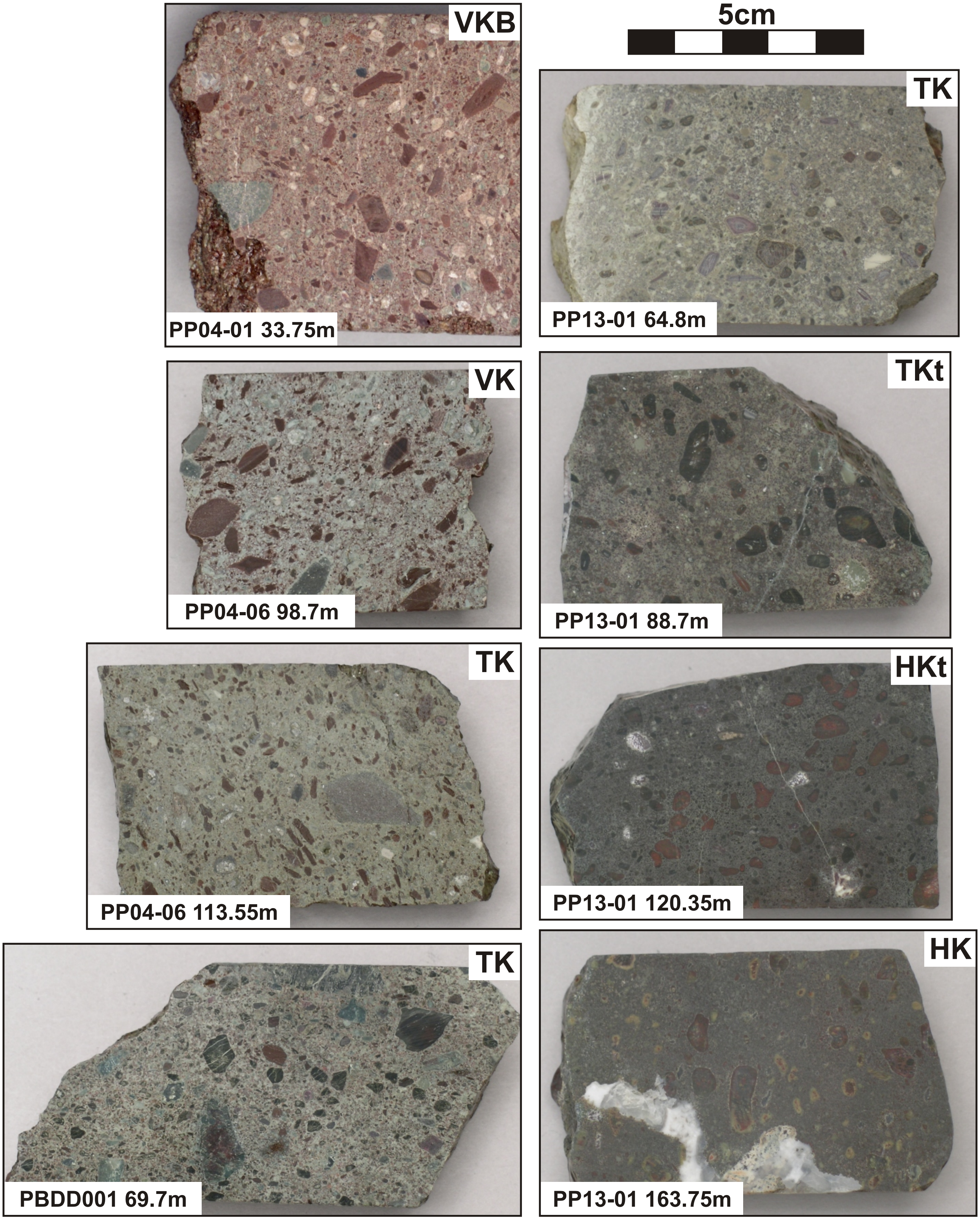

Fig. 3 Polished slabs illustrate the different textures observed in the three pipes. Three samples from Pepper 4 (PP04-01 and PP04-06) show the gradation with depth from VKB to VK to TK, the most obvious feature at this scale being the reduction in xenolith content and change in colour. TK is illustrated from all three pipes, Pepper 4 (PP04-06), Cosmos 1 (PBDD001) and Pepper 13 (PP13-01). The textural gradation from TK through TKt, HKt to HK with increasing depth is shown in one drill hole (PP13-01) from Pepper 13. The petrography of these samples is illustrated in Fig. 4.

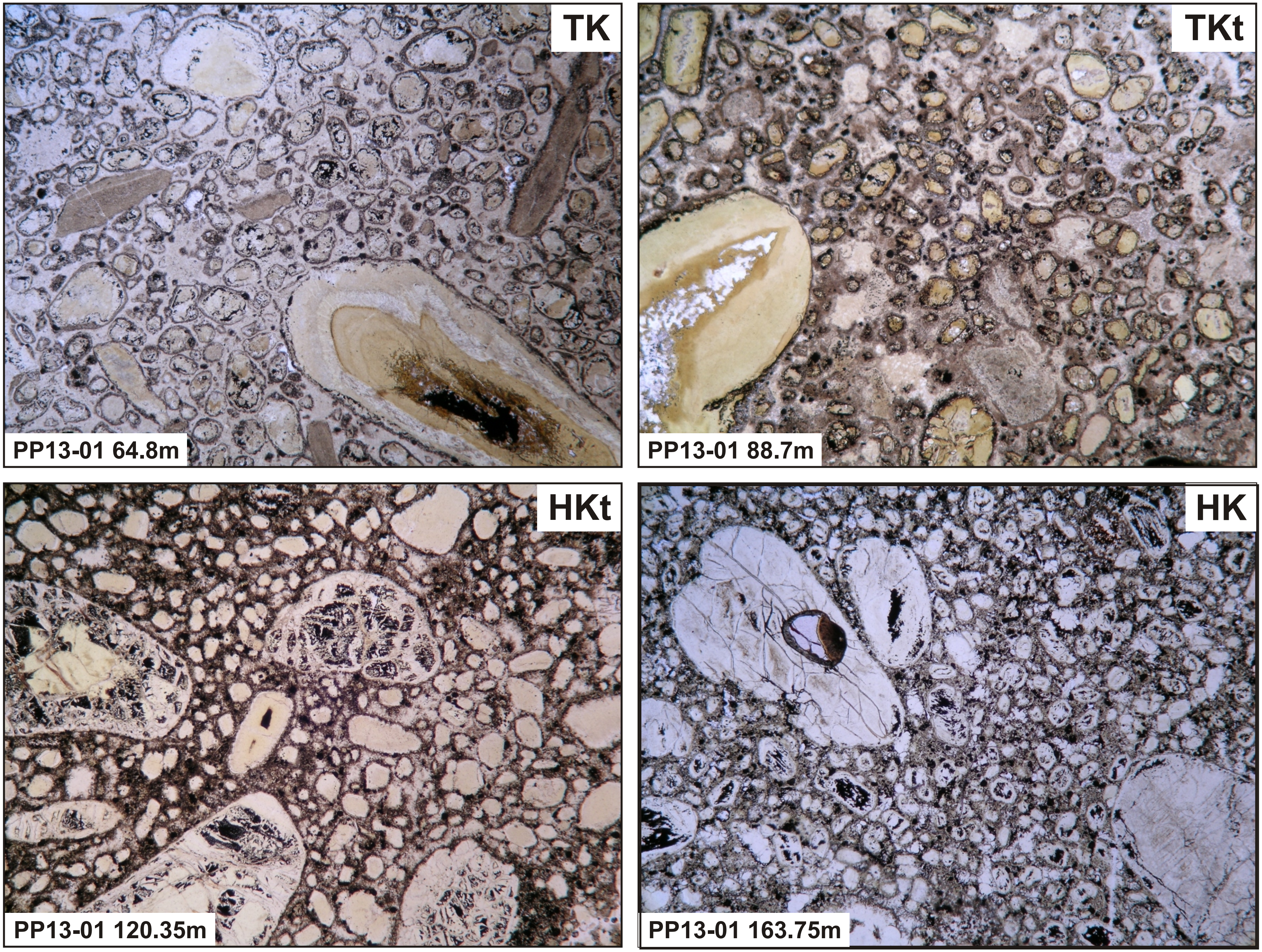

Fig. 4 Petrography of the TK to HK transition is illustrated using the samples from drillhole PP13-01 shown in Fig. 3. Field of view = 7mm. The TK from 64.8m is composed of loosely packed pelletal lapilli. The pelletal lapilli comprise olivine pseudomorphs rimmed with thin selvages of cryptocrystalline kimberlite. The few sediment xenoliths can have similar selvages. The inter-lapilli matrix is serpentine. The TKt from 88.7m is similar to the TK but the pelletal lapilli are not fully separated and the kimberlite selvages are slightly thicker and coarser grained. The HKt at 120.35m has a magmatic texture with segregationary to incipient pelletal lapilli developed in some areas (bottom right). Although not evident at this scale, the TK, TKt and HKt all have microlitic textures. The HK from 163.75m has a uniform magmatic textures and relatively coarse grained spinel and perovskite.

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LONG ABSTRACTS

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