Calciocarbonatite melts in plagioclase megacrysts and xenoliths from Plio-Pleistocene alkali basalt (Slovakia)

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Quenched carbonatite melts occur in basaltic diatreme near Hajnáčka village in the Lučenec basin of southern Slovakia. The 2.60–2.75 Ma old diatreme (Konečný *et al.,* 1995; Vass *et al.,* 2000) together with spatialy associated monogenic maars and lava flows belong to the alkali basalt volcanic province of the intra-Carpathian back-arc basin (the Pannonian basin) originated during post-rift thermal subsidence following aMiocene subduction. The alkali basalts were generated during crustal thinning, astenosphere updoming and partial melting of metasomatised mantle (Konečný *et al.,* 2002; Seghedi *et al.,* 2004). Carbonatite melts occur in inclusions in plagioclase megacrysts, interstitial glass in anorthoclasite xenoliths, as separate carbonatite xenoliths, and isolated globules in kaersutite from clinopyroxene-rich cumulates.

Oligoclase megacrysts ($An_{24-26}Or_{5-6}$), up to 6 cm in diameter, contain rounded melt pockets, composed of ~65 vol% of Ca-carbonatite globules tightly packed in silica-undersaturated (larnite-normative) melilititic glass matrix. About 50 % of the globules contain phosphate-rich domains and almost pure Ca-phosphate globules occupy ~1 % of the inclusion volume (Fig. 1).

Anorthoclasite xenoliths are composed of alkali feldspar (Or_{29-51}) and interstitial Ca-carbonatite melt with dispersed calcite crystals (Fig. 2). Mg-rich ilmenite, apatite and aegirine-augite are present in accessory amounts. Nb-rutile (3.57 % Nb_2O_5) and hedenbergite crystallized as breakdown products of Mg-ilmenite and aegirine-augite, respectively.

Carbonatite xenoliths are composed of quenched Ca-carbonatite glass trapped between radial aggregates of elongated calcite crystals. No other silicate phases have been observed in the carbonatite xenoliths.

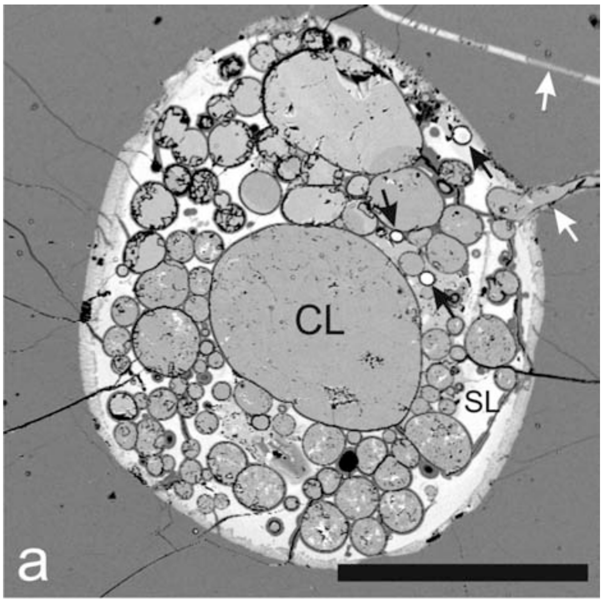

Fig. 1. Back-scattered electron image of a glass pocket in oligoclase megacryst. Variably sized calcio-carbonate globules (CL) are dispersed in alumino-silicate glass matrix (SL). Many carbonate globules contain irregular white phosphate-rich domains, and black arrows indicate three isolated Ca-phosphate globules. White arrows designate cracks with deformed Ca-carbonate globules bulging out into the glass pocket. Black bar scale represents 500 µm.

Textural phenomena rule out the possibility that carbonate globules in plagioclase megacrysts could represent resorbed calcite crystals. Moreover, variable volumes of P-rich domains in the carbonate globules unequivocally document partial immiscibility between the Ca-carbonate and the Ca-phosphate endmember melt phases. Compositions of the coexisting carbonate crystals and melts in megacrysts and xenoliths differ significantly, showing preferential partitioning of Sr in calcite crystals, and P and Mg in the carbonatite melt phase.

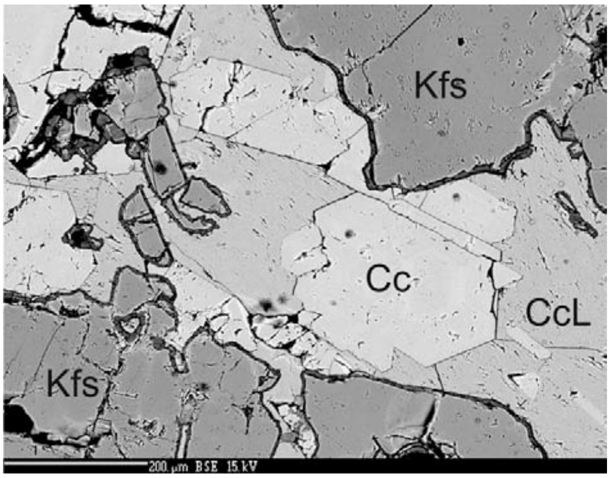

Fig. 2. Anorthoclasite xenolith with carbonatite melt (CcL) and calcite crystals (Cc) interstitial to alkali feldspars (Kfs).

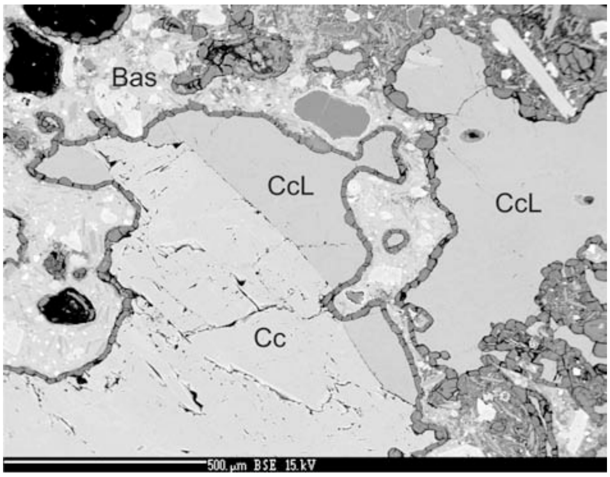

Fig. 3. Xenolith composed of carbonatite melt (CcL) and columnar calcite aggregates (Cc) resorbed from margins by alkali basalt (Bas).

Raman spectroscopy revealed that carbonate globules are well-crystallized phases with main fingerprint bands diagnostic of common low-pressure calcite Ipolymorph. In contrast, missing lattice modes and broader bands indicate alower crystallization degree of the coexisting phosphate globules, showing an isolated lattice mode at 131 cm^{-1} assigned to a Ca-PO_4 bond (Tsuda & Arends, 1994) and downshift of the main stretching $_1PO_4^{3-}$ mode of apatite from 962-964 cm^{-1} to 952-953 cm^{-1}. Vibrations at 1069 and 1017 cm^{-1} have been tentatively assigned to carbonate and sulphate components, respectively, although the latter is sometimes attributed to the triply degenerate antisymmetric stretching $_3PO_4^{3-}$ mode in carbonated hydroxylapatite (Antonakos *et al*., 2007). A weak polarization-dependent band at 682 cm^{-1} was attributed to doubly degenerate $_4$ mode of CO_3^{2-} ion integrated in the apatite lattice (Antonakos *et al*., 2007). A weak band centred at 3561 cm^{-1} corresponds to OH-stretching, although the observed mode was substantially down-shifted from the values of 3572-3575 cm^{-1} typical of hydroxylapatite (Tsuda & Arends, 1994; Yu *et al*., 2007). The shift may be due to substitution of the hydroxyl group by CO_3^{2-} and/or O_2^{2-}.

Preliminary thermodynamic modelling with Perple_X software package (Connolly 2005) and associated databases and solution models showed that crystallisation of plagioclase and alkali feldspar with the observed compositions may occur near solidus of strongly volatile (5 % H_2O, 1% CO_2) high alkaline (8 % in total) phonotephritic melt. Inferred *PT* parameters (720-790°C, 4-8 kbar) are consistent with low-to-middle crustal conditions and the observed assemblage of xenoliths and megacrysts is interpreted as a flotation cumulate from the top of differentiated alkaline basalt magma chamber ejected by later magma portions.

REFERENCES

Antonakos, A., Liarokapis, E., Leventouri, T.(2007) *Biomaterials* 28: 3043-3054.

Connolly J.A.D. (2005) *Earth Planet. Sci. Lett.* 236:524-541.

Konečný, V., Lexa, J., Balogh, K., Konečný, P.(1995) *Acta Vulcanol.* 7: 16-171.

Konečný, V., Kováč, M., Lexa, J., Šefara, J. (2002)*EGS Stephan Mueller Spec. Publ. Ser.* 1:165-194.

Seghedi, I., Downes, H., Vaselli, O., Szakács, A.,Balogh, K., Pécskay, Z. (2004)*Tectonophysics* 393: 43-62.

Tsuda, H., Arends, J. (1994) *J. Dent. Res.* 73,1703-1710.

Vass, D., Konečný, V., Túnyi, I., Dolinský, P.,Balogh, K., Hudáčková, N., KováčováSlamková, M., Beláček, B. (2000) *Geol.Carpath.* 51: 69-82.

Yu, H., Zhang, H., Wang, X., Gu, Z., Li, X., Deng,F. (2007) *J. Phys. Chem. Solids* 68: 18631871.