Carbothermal processes preserved in nosean sanidinites from Laacher See, Eifel, Germany

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Sodalite bearing sanidinites are exotic ejecta observed at Laacher See Volcano, Eifel, Germany. They are hypidio- to holocrystalline magmatic cumulates with trachytic to phonolitic whole rock composition. Main constituent are interlocking sanidine laths creating miarolithic cavities containing crystallizations of the sodalite group. The detailed investigation of different sanidinites revealed systematic changes. The chemistry of the sodalites changes stepwise from Ca-poor haüyne to Na-rich nosean. The mineral assemblage within the cavities of haüyne-sanidinites (HS) consists of haüyne, plagioclase, clinopyroxene and biotite with minor apatite, magnetite and titanite. Typical is the occurrence of vesicle-rich glass. In nosean-sanidinites (NS) glass is absent or subordinate. Major crystals within the cavities are nosean and calcite, with minor clinopyroxene, biotite and apatite. A special feature are (euhedral) crystals of HFSE, including zircon, baddeleyite, pyrochlore. Correspondingly the whole rock composition differs: Compared to HS the NS is (i) enriched in Na, Ca, Mn, S, Cl, Zr, U, Th, Hf, Zn and REE (+LOI), and (ii) depleted in K, Mg, Si, Ti, P, Ba, Sr and V. Furthermore from HS to NS (i) the Ca content of sanidine decreases; (ii) the Na and CO_2 content in the minerals of the sodalite group increases whereas that of Ca and SO_4 decreases; (iii) there is a shift from diopsidic to hedenbergitic composition in clinopyroxene to Mn-rich compositions (15.5 wt.-% MnO).

Etching structures such as jagged or rounded mineral surfaces, and/or holes and veins within the mineral grains indicate the presence of an aggressive fluid phase during the formation of the NS. Abundant fluid inclusions in nosean, zircon and pyrochlore containing CO_2-gas bubbles, but also crystallizations of calcite in etching holes and veins point to the presence of a CO_2-rich fluid phase that caused the mobilization of HFSE and their crystallization in the miarolithic cavities.

All these observations indicate a change from magmatic crystallization of the HS to carbothermal formation of the NS. Accordingly the sanidinates provide a generic link between the Laacher See phonolite magma body and the Laacher See carbonatites. Hence, it is reasonal to suppose a carbothermal formation of Laacher See carbonatites.