Origin and structural character of haüyne in spinel dunite xenoliths from La Palma, Canary Islands

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ABSTRACT

Two spinel dunite xenoliths (Fo89.8–91.2 in olivine) from La Palma contain minor amounts (<1%) of a pale-blue sodalite-group mineral with haüyne/lazurite chemistry. Selected-area electron diffraction (SAED) patterns of this phase indicate a cubic unit cell with dimensions 9.12 ± 0.02 Å, and space group P43n. Superstructure spots along three <110> directions are common, implying commensurate or incommensurate modulations along <110> directions. Raman spectra show peaks typical of both lazurite and haüyne. It is concluded that the mineral has a structure intermediate between those of pure lazurite and pure haüyne, and it is here referred to as haüyness. The haüyness occurs together with strongly nepheline-normative glass in thin veinlets (<0.1 mm), in interstitial glass pockets, and as inclusions in olivine porphyroclasts. To our knowledge lazurite or haüyne has not previously been described in mantle rocks. The haüyness is strongly depleted in REE and most other highly lithophile elements relative to the coexisting glass, whereas D mineral/glass for Sr is = 1.0, and D REE higher than the other REE. The haüyness crystallized from a melt now present as phonolitic glass, probably in response to rapidly decreasing pressure during transport of the xenoliths to the surface. The coexistence of haüyness and FeS-rich sulfide globules in some samples suggests slightly more oxidizing conditions than for samples in which the glass contains sulfide globules alone.

INTRODUCTION

In a study of several hundred spinel peridotite xenoliths from the Canary Islands (La Palma, Hierro, Gomera, Tenerife and Lanzarote; Neumann 1991; Neumann et al. 1995; Wulff-Pedersen et al. 1996; Neumann, unpublished data) a blue sodalite-group mineral with haüyne/lazurite chemistry was observed in two spinel dunites from La Palma. Despite a careful search, this mineral was not detected in any of the other mantle xenoliths.

Lazurite and haüyne are closely related members of the sodalite group; their main difference is that lazurite contains sulfide in addition to sulfate whereas haüyne contains only sulfate (Deer et al. 1992). The ideal formulae are Na₆Ca₂[Al₆Si₆O₂₄](SO₄)₂ for lazurite (Hassan et al. 1985) and Na₆Ca₂[Al₆Si₆O₂₄](SO₄,S)₂ for haüyne (Hassan and Buseck 1989). In both species, Cl and OH may substitute for SO₄ (e.g., Hogarth and Griffin 1976; Hassan et al. 1985; Da Cunha 1989; Tauson et al. 1998). However, none of these criteria work well simply the mode of occurrence (e.g., Hogarth and Griffin 1976; Tauson et al. 1998). The only methods that appear to allow distinction between lazurite and haüyne are structure-related, such as transmission electron microscopy (TEM) and Raman spectroscopy.

Distinguishing lazurite from haüyne is difficult. The methods generally used are color, the presence or absence of S²⁻, or simply the mode of occurrence (e.g., Hogarth and Griffin 1976; Tauson et al. 1998). However, none of these criteria work well (Taylor 1967; Hassan et al. 1985; Da Cunha 1989; Tauson et al. 1998). The only methods that appear to allow distinction between lazurite and haüyne are structure-related, such as transmission electron microscopy (TEM) and Raman spectroscopy.

As far as we know, this study reports the first occurrence of haüyne or lazurite in mantle rocks. The goals of this study were to (1) identify the structure of the blue sodalite-group mineral present in spinel dunite xenoliths from La Palma; (2) determine major and trace element compositions of the sodalite-group mineral and coexisting glass and minerals; (3) determine mineral/melt partition coefficients; and (4) identify conditions of formation.

ANALYTICAL METHODS

The sodalite-group mineral and coexisting glass were analyzed for major elements with an automatic wavelength-dispersive CAMECA electron microprobe fitted with a LINK energy-dispersive system at the Mineralogical-Geological