

## **Re-examination of vesbine in vanadate-rich sublimate-related associations of Vesuvius (Italy): Mineralogical features and origin**

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### **ABSTRACT**

A set of 23 vesbine-bearing samples from Vesuvius volcano (Italy), preserved in the collection of the Royal Mineralogical Museum of Naples, University Federico II (RMMN), have been investigated to identify the mineral assemblages and their mode of formation. In the late 19th century, fumarole-related yellow patinas coating some historical lavas from Vesuvius were believed by Scacchi to contain a new element, vesbium, similar to vanadium in a mineral he called vesbine. Subsequent studies rejected vesbium and showed that vesbine was a poorly defined mixture of copper vanadates and halides. The vesbine samples studied here consist of yellowish to yellow-green-blue encrustations on Vesuvius lavas and have been analyzed by combined optical microscopy, SEM-EDS, XRPD, FTIR, and TEM-HRTEM-EDS. Results reveal complex mineral associations, including vanadates, halides, carbonates, oxides, silicates, tungstates/molybdates, and sulfates. The vanadates correspond to mottramite, volborthite, and vanadinite; subordinate amounts of descloizite were detected by XRPD and FTIR investigations. Several additional non-essential elements have been detected in the vanadates, including Mn, Zn, and As. The occurrence of wulfenite- and stolzite-rich phases indicates the presence of Mo and W, along with Pb, in the mineralizing fluids. Mn-rich phases, commonly in mixtures with silicates and vanadates, were also observed. These minerals are formed by a combination of different processes, including rock-fluid interactions, gas-water interactions, and alteration/oxidation of primary fumarolic minerals. Temperatures for the depositions of the vanadates-bearing assemblages are interpreted to be in the range of 100 to 400 °C.

**Keywords:** Vanadates, vesbine, volborthite, mottramite, vanadinite, copper-bearing minerals, fumaroles, Vesuvius