Magmatic-hydrothermal ore-metal mineralization in the Taupo Volcanic Zone (TVZ), New Zealand

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In studies of the ore deposition potential of the TVZ, the focus has been on active hydrothermal systems for >40 years. However the Ruapehu and White Island phreato-magmatic eruptions provide information on ore-related metallization from magmatic-hydrothermal and magmatic sources in lieu of deep geothermal wells. Ashes, ash leachates and volcanic ballistics from both volcanoes contain significant amounts of ore-related metals including Cu, Pb, Zn, Ag, Sb, Fe, Ti and As as sulfides, chlorides, oxides or native elements, apart from native S and various compounds containing Na, K, Ca, Sr, Ba, F and B. Metals ejected during volcanic eruptions in 1995-2016 may be contained in: juvenile andesite, altered rock with source temperatures up to >300^{o}C within the magmatic-hydrothermal interface, crater lake products and the volcanic plume. As, Cu, Ag and Sn in the juvenile andesites are higher than crustal contents and apparently trapped in melt inclusions or glassy mesostasis where pyrite and Cu-Fe sulphides were observed. The crater lakes are fluid-dominated acid hydrothermal systems where the reaction of bedrock, lake water and condensed magmatic volatiles induce deposition of sulfur, natroalunite, Fe-sulphates and sulfides such as pyrite and Cu-(As)-(Fe) sulfides; with Ca-sulphates, barite and rare celestine deposited during intervals of volcanic repose and meteoric water/seawater influx. In ashes the morphologies of crystals containing Ca, Ba, Sr, Ti, Zn, Fe and Pb indicate either direct sublimation from the eruptive plume or condensation of vapour prior to deposition. This study shows that reducing sulfur-rich conditions suppress metal deposition except for rare pyrite whilst oxidizing acidic to near-acidic conditions deposit Cu (Fe-As)-sulfides, natroalunite, kaolinite and Fe-bearing sulphates. Thus, the TVZ has the potential for ore-related metallization not only from hydrothermal systems but also from magmatic-hydrothermal to magmatic depths provided conditions for concentrating ore-related metals exist.