

CHLORITE FROM HYDROTHERMAL VMS Fe-Cu-Zn SULFIDE DEPOSITS IN THE NORTHERN APENNINE OPHIOLITES (ITALY)

FEDERICA ZACCARINI*, GIORGIO GARUTI

Department of Geosciences and Geophysics, University of Leoben, Leoben, Austria

*federica.zaccarini@unileoben.ac.at

The Fe-Cu-Zn volcanogenic massive sulfide (VMS) deposits associated with the Northern Apennine ophiolites of Italy have undergone only weak sub-oceanic metamorphism and contain chlorite in different mineralogical environments: type-1) in sulfide mineralized hydrothermal veins of quartz and carbonate cutting across mafic-ultramafic rocks, type-2) in basalt, gabbro and serpentinite as a result of convective circulation of thermally-modified seawater below the sub-oceanic floor, and type-3) as detrital sedimentary mineral accumulating on the sea-floor at the venting site of metalliferous brines. Due to its great range in composition chlorite exists over a wide range of temperature and pressure conditions. Therefore, chlorite may occur in metamorphic, igneous, hydrothermal and sedimentary rocks. On the basis of more than 1000 electron microprobe analyses, chlorite in the Northern Apennine VMS deposits reflects the different environments of crystallization, showing changes in temperature, interaction with the host rock and composition of the parent hydrothermal fluids. Type-1 chlorite occurring in quartz-carbonate veins in basalt is dominated by Mg-Fe substitution, at constant Al^{VI} , and relatively high Mn-Cr ratio, similar to the chlorite of type-2 in basalt and gabbro. Type-1 chlorite associated with quartz-carbonate veins cutting across serpentinite shows a concomitant substitution of Mg for Fe and Al^{VI} , and high Cr-Mn ratio. Type-3 chlorite from the sea-floor, stratiform deposits is relatively enriched in Al^{VI} with variable Fe-Mg ratio resulting from the mafic or ultramafic nature of the substratum. The Fe-Mg- Al^{VI} exchanges in the octahedral site of the VMS Northern Apennine chlorites resemble those of the chlorite from metabasic rocks that crystallized over a wide range of metamorphic conditions. This similarity in chlorite composition seems to be essentially related to the similarity between the mafic-ultramafic protoliths that have generated both the chlorite in the Northern Apennine deposits and metabasic rocks. Other factors, such as seafloor or sub-seafloor environment of precipitation, have influenced the temperature of chlorite crystallization, causing an increase of the amount of Al^{IV} , that substitutes for Si in the tetrahedral site with increasing temperature. Temperatures obtained from type-1 and type-2 chlorites are comprised between 85-360 °C, with more than 90% of data plotting between 200 and 310 °C. In contrast, chlorite from sea-floor stratiform ores crystallized at relatively low temperatures, in the range of 50 and 298 °C, with 85% of the values clustering at 100-200 °C. Although exchanges in the octahedral site of chlorite, involving Fe, Mg, Al^{VI} , and the other minor elements Cr and Mn appear to be influenced by the mafic or ultramafic nature of the rocks hosting the VMS deposits, our mineralogical data suggest that the thermometric significance of the investigated chlorite is well consistent with the geological constraint of the different deposits. This observation confirms that, under the appropriate conditions, the chlorite composition can be used as a reliable geothermometer. The chemical composition of the investigated chlorite, in terms of Si contents and distribution of some trace elements, is probably also controlled by the nature of the mineralized hydrothermal fluids.