ZONING IN LAURITE: A KEY TO UNDERSTAND THE GENESIS OF OPHIOLITE CHROMITITES

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INTRODUCTION

The platinum-group minerals (PGM) of the laurite (RuS_2)-erlichmanite (OsS_2) solid solution series are the most common PGM in chromite ores hosted by mantle peridotites of ophiolite complexes. They occur mostly as small (usually below 20 µm) mineral inclusions in chromite. Most authors agree that these minerals form at high temperatures, slightly prior or coeval with the crystallization of chromite. Thus, growing chromite tends to trap these PGM, preventing any further chemical exchange with the melt. Because the composition of laurite-erlichmanite is strongly influenced by sulfur fugacity and temperature, each individual, sealed inclusion records valuable information on the conditions prevailing during its crystallization.

The study of different zoning patterns in laurite-erlichmanite crystals from chromite deposits, located in different ophiolite complexes allows us to investigate the thermodynamic changes occurring during their crystallization and to discuss the origin of such changes.

PATTERNS OF ZONING

The observed patterns of zoning can be classified on the base of variations in Ru/(Ru+Os) ratio, into three groups: i) simple patterns formed by an anhedral to subhedral Ru-rich core, surrounded by a variably thick, Os-rich rim (normal zoning); ii) simple patterns formed by an anhedral to subhedral Os-rich core surrounded by a variable thick, Ru-rich rim (reverse zoning); iii) complex patterns exhibiting irregular, alternating bands of variable thickness, characterized by different Ru/(Ru+Os) ratios (oscillatory zoning). Some patterns show growth–related bands, parallel to crystal faces which are frequently interrupted by the external boundary of the grain, suggesting partial dissolution of the zoned grain. Few of these grains contain rounded inclusions of Ni-Cu-Fe sulfides (probably former droplets of sulphide melt) arranged along growing bands. In addition, irarsite (IrAsS) can occur either attached to the outermost rim, or forming bands between those of laurite-erlichmanite. The contact between laurite-erlichmanite and irarsite is very irregular and irarsite cuts the growth-related bands of laurite-erlichmanite, again suggesting slight dissolution prior to the crystallization of the latter phase. Os-Ir alloys are also attached to the outermost rim when such rim consists of Ru-rich laurite (in reverse and oscillatory zoning).

DISCUSSION AND CONCLUSIONS

As fS_2 tends to increase on cooling, normal zoning would record eventual drops in temperature before complete trapping of laurite. However, a continuous decrease in temperature and increase in fS_2 cannot explain either the reverse or the oscillatory patterns of zoning. To account for such chemical variations (including eventual increases in the arsenic fugacity to form irarsite) it is necessary to invoke a mechanism capable to create different fS_2 gradients (up to the values necessary to generate an immiscible sulfide melt) in space and/or time with or without changes in temperature. Such variable fS_2 gradients could generate during the crystallization of chromite by magma mingling as a consequence of the turbulent regime created by the input of different batches of melt. The turbulent mingling of two melts can create local differences in the chemistry of the hybrid melt, in fO_2 and in fS_2. Temperature can also change as a partly fractionated melt mingled with a new, slightly hotter primitive melt. In this scenario, crystallizing laurite can overgrow or dissolve depending on the local, variable physico-chemical conditions, giving rise to different patterns of zoning.