Some problems concerning mass-balance estimates related to hydrothermally altered cumulates in the lower section of the Beja-Acebuches Ophiolitic Complex [2]

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The ultrabasic and basic rocks that form a thin belt outcropping between Beja (Portugal) and Acebuches (Spain), corresponds to a tectonically dismembered variscan ophiolite. The lowermost sections of the ophiolite sequence are particularly well preserved in Portugal and comprise mainly cumulates of harzburgitic and dunitic nature sometimes associated with pyroxenites, above which there is a thick "level" of (flaser) metagabbros with trondhjemitic intrusives. Early metamorphic mineral assemblages recording the establishment of high-T and low-P granulite conditions can be recognized in metagabbros and in some (less serpentinized) harzburgites. Subsequent retrogradation to amphibolitic facies conditions can easily be identified, predating the widespread serpentinization.

Major left-lateral shear zones, generated during the early collisional stages and object of successive reactivation in the course of the late-variscan deformation events (during which they acquired thrust left-lateral movement), put in contact distinct levels of the ophiolite sequence and represent the major conduits for syn- and late-deformational CO_2 and SiO_2 fluid flows which are responsible for: 1) strong and heterogeneous metasomatism (carbonatization and silicification) of the adjoining rocks; and 2) the development of deeply leached hydrothermal precipitates along the main shear zones that usually comprehend silicified aggregates of dolomite + ankerite cut by several families of polyphasic carbonate ± microcristalline quartz aggregates.

A set of cumulates were used to perform some mass-balance estimates in order to have a general picture of the relative mobility of elements associated with the most important metassomatic transformation (namely carbonatization) of these rocks. In this study the equation proposed by Gresens was used. The samples used as standard reference for the mass-balance calculations were chosen after careful petrographic examination and only metasomatized samples for which it was possible to derive the parent rock, either by its mineralogy or by textural features, were considered. Also, very distant samples were not used, because of significant primary rock heterogeneity.

For the gabbroic rocks, it was observed that in most situations a volume factor greater than 1 must be assumed, otherwise the altered carbonatized rock would loose part of all its major elements, and no evidence for that exists macro and microscopically. Therefore a volume gain of 10% was generally considered, assuming the immobility of a series of minor elements (Zr and/or some REE). Chemically, this means systematic gains of CaO (as a result of carbonatization) and Al_2O_3 losses (sometimes in the order of 15 wt.%) mainly due to plagioclase breakdown. Generally, SiO_2 and MgO losses occur as well, the few cases where gain of these elements is observed meaning the existence of a silicification event or, in the totally carbonatized rocks, the existence of ultrabasic rock fragments within the carbonatized samples respectively. As a mater of fact, textural relationships between quartz and carbonates suggest that quartz has dissolved as carbonate precipitates. For the minor elements, Ba and Sr show systematic losses.

For the serpentinized peridotites the scenario is much more complicated since the same analysis indicates that all major elements are mobile regardless of the considered volume factor, and no reliable reference may be found using minor elements. However, the general trend that may be pictured is not much dependent on the volume factor considered, and, supported by mineralogical evidence, we have calculated volume factors considering Cr as an immobile element. This implies volume factors of 1 or close to 1.2 (depending on the sampled area). Therefore, as with the gabbroic rocks, significant gains of CaO occur, as well as important losses of MgO (in the order of 20 wt.% or even more). MgO may locally rise significantly but this is due to late re-concentration and precipitation of magnesite and Mg-rich dolomite veins. Al_2O_3 is kept almost constant and, when analytical values are available, SiO_2 may be lost in small amounts. As for the minor elements, Cu, Zn, Ni and Co are systematically depleted which correlates well with the alteration of the sulphide minerals. Contrary to the gabbroic-derived metasomatized rocks, there is generally an increase of Ba and Sr.

Finally, some ultra-metassomatic rocks that may be gabbroic-derived (mainly on the basis of relict textures and contrasting grades of minor elements such as Cr) show general losses of most major elements no matter what volume factor is considered. This may indicate a major heterogeneity related with the incorporation of elements from ultrabasic rocks, which may make this analysis invalid. However, if such contribution exists it is of minor importance because of the above arguments, and the possibility that an effective volume loss might be accommodated by the tectonic compression should be properly accounted for and further investigated.

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