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Petrology of the Alto Condoto ultramafic-mafic complex, Colombia

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Alaskan-type ultramafic-mafic complexes (ATC) are a type of layered intrusions with a high economically relevance due to their high platinum group elements (PGE) abundances. Recent investigations of ATC worldwide show their common signature.

The Alto Condoto ultramafic-mafic complex is located in the Northwest of Colombia, South America. It is part of the Western Cordillera of Colombia, which probably represents an immature volcanic arc. Earlier radiometric age dating revealed an age of 20 Ma which would make it the youngest known ATC [1]. Despite its high economic potential no detailed study on mineral compositions was published on Alto Condoto. A correlation with the associated Viravira complex is highly probable.

A new sampling campaign of Alto Condoto was conducted in spring 2011. Sampled lithologies range from true dunites over clinopyroxene-bearing dunite, wehrlite and olivine clinopyroxenites to almost true clinopyroxenites and hornblendites. Their degree of alteration is generally low and no orthopyroxene could be identified on macroscopic or microscopic level. Grain sizes vary between 0.2 to 10 mm at all lithologies. Olivine-bearing rocks show cumulate texture with perfect 120 ° grain intersections in places. Mineral replacement and exsolution textures can be observed in many samples.

The dunites occur dominantly in the center of the intrusion. They consist of 95 to 99 % olivine and 1 to 5 % chromian spinel and magnetite. Kinkbands and undulose extinction in olivine is visible under the microscope. Some dunites are crosscut by 0.1 to 2.5 mm thick veins of clinopyroxenite.

Clinopyroxene abundances increase from less than 10 % in clinopyroxenitic dunite to nearly 100 % in olivine-bearing clinopyroxenites with increasing distance to the center of the intrusion. Olivine modes change concomitantly from 80 % to rare single grains, while magnetite and chromian spinel range between almost none to about 5 % throughout. With increasing percentage of clinopyroxene the proportion of chromian spinel decreases while the proportion of magnetite increases. In some samples hornblende occurs in minor amounts. The clinopyroxenes show no visible zonation under the microscope but orthopyroxene exsolutions are common and partly restricted to grain cores.

Hornblendites composed of hornblende (about 80 %) and apatite (about 15 %) represent the most evolved rocks in this sample set. Only magnetite and ilmenite, which often are intergrown, occur as oxide phases and no chromian spinel exists.

Oxide compositions are characterized by high Fe3+ contents and show a correlation with the lithology. They indicate cooling of the intrusion down to a temperature of about 600 °C. Application of the Fe-Ti oxide oxybarometer supports this temperature estimate.

The concentric structure, range of ultramafic rocks, complete absence of orthopyroxene, type of PGE composition [1], high Fe3+ content in oxides underscore the classification of the Alto Condoto ultramafic-mafic complex as an ATC.

[1] Tistl, M. et al. (1994): Origin and emplacement of Tertiary ultramafic complexes in Northwest Colombia: evidence from geochemistry and K-Ar, Sm-Nd and Rb-Sr isotopes. EPSL 126, p. 41–59.