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Tourmaline Composition Near a Diorite Intrusive Body Under La Cuaba Lithocap (Ampliación Pueblo Viejo District, Dominican Republic)

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INTRODUCTION

Tourmaline has become a much appreciated mineral by mineralogists, petrologists and geochemists in the last two decades; the reason is the step forward in new analytical methods, especially those of *in situ* analyses (e.g. EMP, LA-ICP-MS, SIMS) that allow the extraction of large amounts of information that is contained in this mineral. The issue that the prestigious magazine *Elements* (Dutrow & Henry 2011) has devoted to tourmalines is proof of this increasing interest.

This borosilicate is now referred to as a supergroup. Its general formula is $XY_3Z_6[T_6O_{18}][BO_3]_3V_3W$ where X= □, Na, K, Ca, Pb^{2+}; Y= Li, Mg, Fe^{2+}, Mn^{2+}, Cu^{2+}, Al, V^{3+}, Cr^{3+}, Fe^{3+}, Mn^{3+}, Ti^{4+}; Z= Mg, Fe^{2+}, Al, V^{3+}, Cr^{3+}, Fe^{3+}. T= Si, B, Al; B= B, V= OH, O and W= OH, F, O (Henry et al. 2011). Considered a highly robust mineral, it is capable of preserving textural, chemical and isotopic features over a wide temperature and pressure range. Thus, it can be used to constrain the nature and evolution of ore forming fluids (Pirajno & Smithies 1992; Talikka, & Vouri 2010; Slack & Trumbull 2011).

During the study of thin sections of drill cores from an intrusive body in the Ampliación Pueblo Viejo (APV) district (Dominican Republic), located next to the famous gold-silver Pueblo Viejo deposit, a significant amount of tourmaline was detected in some samples. As our intention was to characterize alteration horizons and as a tourmaline has been successfully used as a prospection tool in many types of hydrothermal deposits, an in- depth study of these tourmalines was proposed.

Here we present the first data of APV tourmalines including textural, chemical and mineralogical characteristics. Some interpretations from these data are proposed in order to constrain the hydrothermal fluid characteristics and its evolution.

GEOLOGICAL SETTING

The APV concession consists of 4,045 hectares adjacent to the northern edge of Barrick/Goldcorp's Pueblo Viejo mine. It is centred on 10 Km south of Cotui, in the central portion of Dominican Republic, Island of Hispaniola, in the northern Caribbean Sea.

The Cretaceous-Eocene Circum-Caribbean island-arc system is a complex collage of crustal units or terranes which formed and accreted within an intra-oceanic environment since Late Jurassic – Early Cretaceous times (Lewis et al. 2002).

The outcropping rocks in APV belong to the Early Cretaceous Los Ranchos Formation, the same unit that hosts the ore deposits of the Pueblo Viejo district (Nelson 2000). This unit is part of the oldest and chemically most primitive island arc and is composed of boninites, LREE-depleted tholeiitic island arc basalts, and normal island arc tholeiites with an interval of felsic volcanism and plutonism dated at 110-118 Ma and shallow marine carbonaceous sediments (Nelson et al. 2011).

RESULTS

35 thin sections were prepared for study by petrographic microscope and SEM. 5 of the samples were analysed by EMPA (CAMECA SX50) at the Centres Científics i Tecnològics of the University of Barcelona.

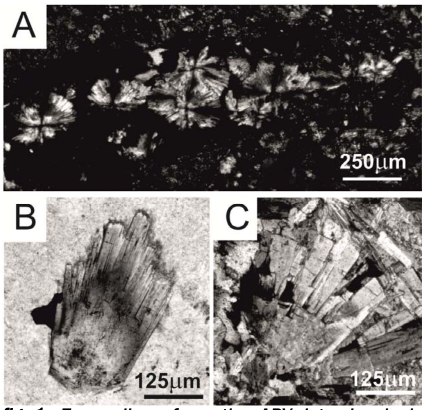

fig 1. Tourmalines from the APV intrusive body under petrographic microscope, transmitted light. A. Vein made up of type I tourmaline radial aggregates. (B, C) Type II tourmaline crystals.

Two generations of tourmaline can be distinguished.

- Type I consists of acicular crystals forming radial aggregates. In these crystals, a strong colour change occurs under petrographic microscope; the top of the needles is colourless whereas the base and the core are dark green in colour. These small ball-like aggregates often occur forming sub-millimetric veins cutting the bulk rock (Fig. 1A).
- Type II occurs as aggregates of prismatic rather stubby crystals often grouped forming bundles (Fig. 1B-C). A colour zonation can be noticed both in longitudinal and in basal sections. the prismatic crystals seem to begin to grow as divergent aggregates above an equi-dimensional tourmaline crystal. Type II tourmalines appear scattered in the bulk-rock cutting all the mineral assemblages.

palabras clave: Turmalina, Pórfido, Alteración, Química mineral. | *key words:* Tourmaline, Porphyry, Alteration, Mineral chemistry.

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The chemical composition of the tourmalines has been plotted in the diagrams proposed by Henry et al. (2011) (Fig. 2) in order to classify them.

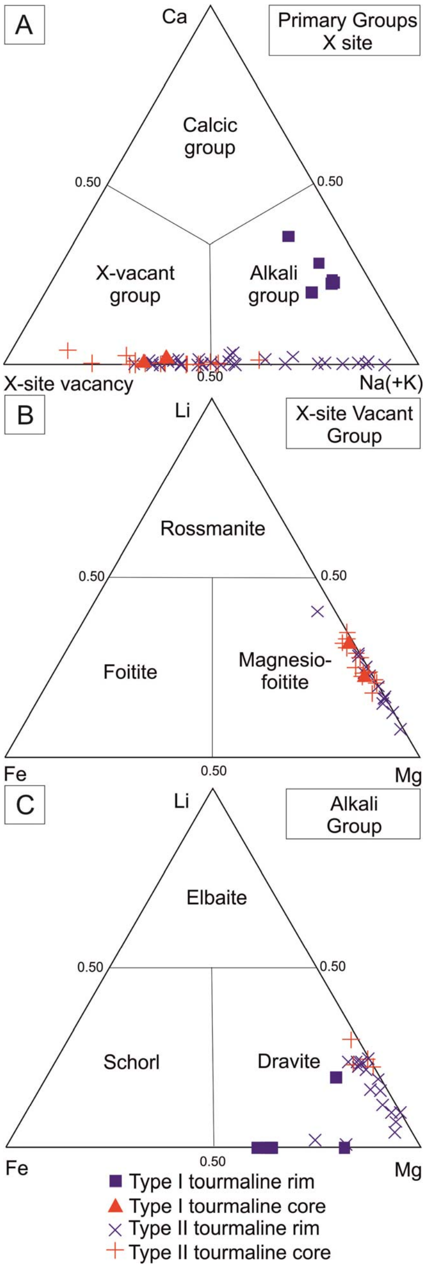

fig 2. Classification of the APV tourmalines by chemical composition in the diagrams proposed by Henry et al. (2011).

All analysed tourmalines belong to the X-vacant and alkali groups according to the primary division. For the analysed points corresponding to the rims of type I tourmalines, their higher Ca content in the X-site is remarkable. The remaining tourmalines are Ca-poor and practically all occur in the complete range between the X-site vacancy and Na end members.

There is a division between the analysed points in the cores and rims which is biased towards the X-vacant group end member.

According to the secondary diagrams (Fig. 2B-C), APV tourmalines belong to the dravite and magnesio-foitite tourmaline species, the last being extremely Fe-poor. A tendency towards Fe enrichment occurs for dravite specimens, especially for the rims of those of type I. This Fe-enrichment trend from core to rims is much more evident in Fig. 3. An inverse relation between Fe enrichment and X-site vacancy becomes evident in this graphic.

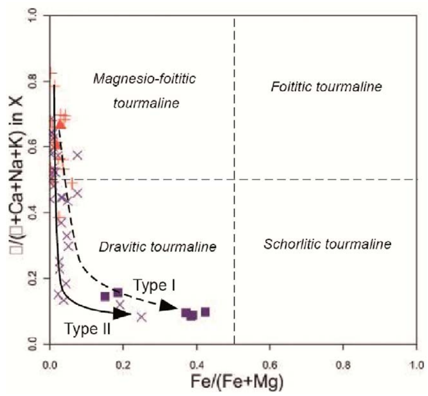

fig 3. Chemical representation of vacancy proportion in X-site versus the Fe/(Fe+Mg) ratio of the APV analysed tourmalines.

DISCUSSION AND CONCLUSIONS

There is a considerable range of tourmaline composition in the APV district with respect to major elements; this variation occurs for single crystals, regardless of the host rock. As tourmaline composition is governed largely by those of the hydrothermal fluid, Fe-rich tourmalines are often associated with magmatic hydrothermal fluids whereas Mg-rich ones are thought to be related with seawater. With regard to the Na, low Na content in tourmaline reflects low salinities of the fluid (Slack & Trumbull, 2011). Thus, chemical evolution during APV tourmalines growing indicates a trend toward increasing magmatic hydrothermal influence. Similar trends are described by Collins (2010), who indicates that they may reflect a more effective leaching and transport of metals fluid.

Los Ranchos' materials have been usually described as spilites and keratophyre (Vennemann et al. 1993), in which seawater influence is implied by definition. Magmatic hydrothermal fluids could be related with the new dioritic body found in the drill holes and that now are under study. For the Pueblo Viejo high-sulfidation epithermal Au deposit, a related intrusive body counterpart has never been described (Sillitoe 2010). Further analytical (currently under way) is necessary in order to better constrain the hydrothermal fluid characteristics and to be able to correlate the timing of each tourmaline composition with the stages in ore mineralization and in diorite emplacement. LA-ICP-MS and B isotope studies are planned.

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