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Chemical Characteristics of Emeralds from Various Localities

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Emeralds can be distinguished into two main types of geological occurrences based on their relation to the host rocks: Type I deposits - non-schist-related emerald mineralization, Type II deposits - schist-related emerald mineralization. In this study a total of 23 emerald samples from 7 different geological occurrences (Nigeria; Colombia; Brazil: Santa Terezinha, Carnaiba/Socoto, Itabira; Madagascar; and Zambia) were chemically analyzed by Laser ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) for the concentrations of 16 trace elements; Li, Be, B, Na, Mg, Al, Si, P, K, Ca, Ti, V, Cr, Mn, Fe and Cs. The chemical data imply that the most common substitution found in emerald structure from majority of the deposits is that of Al3+ by (Mg +Fe)2+ in octahedral site which is accompanying by charge compensation of Na+ (and probably with Cs+ and K+ in some deposits) in channel site. Other important substitution of Al3+ is by Cr3+ and V3+ (which is responsible for the green color of those emeralds) and probably by Fe3+ in octahedral site in some deposits. The replacement of Li+ and possibly Na+ for Be2+ in tetrahedral site could also occur in some deposits. The emerald samples from Brazil, Madagascar and Zambia (Type II deposits) show relatively moderate to high values of alkali elements (Na, Mg, Li, Cs) and Fe while those from Nigeria and Colombia (Type I deposits) are relatively low. The highest content of trace elements can be found in emerald from Santa Terezinha, Brazil (Type II), whereas those from the Kaduna Plateau, Nigeria (Type I) show the lowest value. Na, Mg and Fe are among the highest trace element and have the strongest influence on RI and SG of those emeralds. The Type II schist-related deposits show relatively higher values (the highest RI and SG values are found in emerald from Santa Terezinha) while the Type I non-schist-related deposits have somewhat lower values (the lowest RI and SG values are found in emeralds from Nigeria). The emeralds from Zambia and Carnaiba/Socoto contain relatively high contents of Li and Cs while the emeralds from Madagascar show exceptionally high K content. The Colombian emeralds contain rather low Fe content (which is consistent with UV-Vis-NIR spectra). The emeralds from the Type II deposits (Santa Terezinha, Carnaiba/Socoto and Itabira, Zambia and Madagascar) contain higher Cr than V contents (Cr/V $>$ 1) whereas those of the Type I deposits (Colombia and Nigeria) have lower or approximately equal proportion of Cr and V contents (Cr/V $<$ or $\sim$ 1). This data implies that Cr might have been the important colouring element in the Type II schist-related deposits while both Cr and V are equally significant colouring elements in the Type I non-schist-related deposits.