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Optimized conditions for cobalt diffusion in Sri Lankan colorless topaz and coloration mechanism elucidation through spectro-chemical investigation

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Abstract

Most of natural topaz is colorless; thus, methods of color enhancement are widely used for coloring this mineral. Currently, blue color is obtained by cobalt diffusion due to drawbacks in existing coloration methods. In this study, optimum conditions suitable for Cobalt diffusion in Sri Lankan colorless topaz were investigated and coloration mechanism was elucidated. The diffusion agent was prepared by mixing $CoCO_3$ with Na_2CO_3, $CaCO_3$ and carbon powder and diffusion was carried-out by varying the temperature and soaking time. Chemical analysis, UV-Vis absorption spectrum, infrared absorption spectra, and Raman peaks of diffused and non-diffused topaz were tested. The results clearly indicated that the optimum condition for Co diffusion in Sri Lankan topaz is 950°C for 11 h. The EPMA analysis showed that the Co concentration in the diffused sample varied from 0.001 wt% to 0.027 wt% while colorless topaz showed <0.001 wt%. The UV-Vis spectrum of Co diffused blue topaz gave three absorption peaks at 556, 588, and 627 nm corresponding to three spin-allowed electronic transitions of Co^{2+} ion in teterahedaral coordination. In case of Co diffused topaz, one additional new broader IR absorption peak was noticed around 6640 cm^{-1} presumably arising by optical transitions of $^4A_2 \rightarrow {}^4T_1$ in Co^{2+} (^4F). Our results lead to the conclusion that, blue color of the Co diffused topaz is arising by spin-allowed electronic transitions of Co^{2+} ions in tetrahedral site of topaz matrix through substitution of Si^{4+} ions.

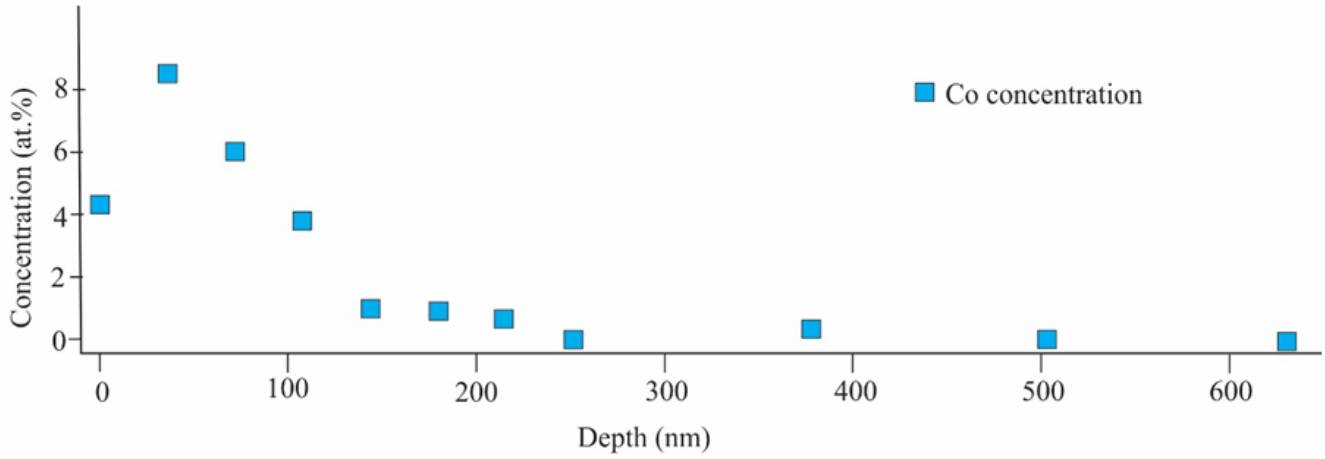

Figure S1. The graph shows the distribution of the color-causing element of Co with depth in typical Co-diffused blue topaz. Modified after [5].