

THE NATURE OF IRRADIATION-INDUCED PHANTOMS IN NATURAL QUARTZ

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The origin of 'phantoms' in natural quartz crystals is discussed in many publications, nevertheless, most explanations are plausible but lacking proof. White, green, orange, red, brown and other coloured 'phantoms' owe their colour to mineral inclusions like chlorite, carbonates, mica, rutile, hematite, boulangerite, and graphite, among others. They represent a juvenile state during growth, at which foreign particles deposited on crystal planes due to changes of the growing conditions in the hydrothermal melt. This explanation is oversimplified and 'phantoms' are of diverse origins, including anisotropic impurity incorporation and segregation. The present study reports the results of gamma irradiation followed by thermal treatments of colourless natural quartz from different Brazilian localities. Some quartz crystals develop sharp patterns of lines and planes of a smoky-grey shade contrasting with the vivid greenish-yellow backgrounds. Supported by electron-microprobe chemical maps we demonstrate that these phantoms formed in areas of high concentration of Al substituting Si in localised regions of the crystals compared with lower concentrations in the background. The electron paramagnetic resonance studies reinforce this observation by detecting a much higher concentration of $[AlO_4]^\circ$ colour-centres in regions with high density of phantoms compared to the background regions.