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Spectroscopic and related evidence on the coloring and constitution of New Zealand jade

CUTHBERT J. WILKINS,[1] W.CRAIGHEAD TENNANT,[1,*] BRYCE E. WILLIAMSON,[1] AND CATHERINE A. MCCAMMON[2]

[1]Department of Chemistry, University of Canterbury, Private Bag 4800, Christchurch, New Zealand
[2]Bayerisches Geoinstitut, Universität Bayreuth, D-95440 Bayreuth, Germany

ABSTRACT

Infrared, optical absorption spectroscopy, and Mössbauer spectroscopy were used to investigate the color of jade from New Zealand. Spectroscopic results were supplemented by chemical analyses and petrological examination. Infrared spectra gave a quick identification of the matrix, optical absorption spectra gave information on color in relation to observed absorption bands, and Mössbauer spectra gave the distribution of Fe^{2+} and Fe^{3+} at the cation sites and also show how the Fe^{3+}/Fe^{2+} ratio increases due to oxidative weathering. The development of the attractive flecking in the gem-quality jade is due to agglomerations of colloidally dispersed magnetite or chromite that can also lead to the formation of black spots. Darker samples are generally high in total iron, although not all lightly colored (or pale) samples are low in iron—cream or white unweathered nephrite can also contain high iron concentrations. Weathering under the climatic conditions where the samples occur can produce either a brown, hydrated iron oxide, or a whitish outer rind if the acidity is high enough to remove the oxide. In either case the nephrite matrix is unaltered. Two quite rare variations were found and ascribed to: (1) incomplete nephrite formation in samples developed in association with an unusual ultramafic protolithology and (2) the formation of chromian margarite giving rise to a bluish-green (pseudo) jade.