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Characterisation and origin of New Zealand nephrite jade using its strontium isotopic signature

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Abstract

Nephrite jade occurs in three terranes (Dun Mountain–Maitai, Caples and Torlesse) in New Zealand, where it is associated with ultramafic and ophiolitic rocks in narrow metasomatic reaction zones at the margins of serpentinite (having harzburgite/gabbro/dolerite precursors) with silicic metasediments and metavolcanics. True nephrite fabrics are developed only locally where marginal shearing is intense, and late in the metamorphic history. $^{87}Sr/^{86}Sr$ values of these nephrites do not display the primitive values of their gabbro/dolerite precursor component i.e. 0.7030–0.7035, as expected if formed during serpentinisation. Rather, the nephrites have more evolved $^{87}Sr/^{86}Sr$ values inherited from the metasediment component at a later stage, and which fall within particular terrane groups: Dun Mountain–Maitai 0.7045–0.7060, Caples 0.7058–0.7075 and Torlesse 0.7085–0.7110. Rb–Sr ages and initial $^{87}Sr/^{86}Sr$ ratios of the metasediment component from *in situ* nephrite localities, when compared with their counterparts throughout the host terrane, show that nephrite Sr isotopic compositions are characteristic of the host terrane.

Keywords: Nephrite; Jade; Greenstone; Pounamu; Rb–Sr dating; Strontium isotopes

1. Introduction

Jade is a semiprecious gemstone and, although rare, is found widely around the world, particularly in ultramafic rocks associated with ophiolite complexes and in metamorphosed dolomites (Harlow and Sorensen, 2005). Jade is essentially a monomineralic rock that occurs in two forms: most commonly as a tremolite–amphibole type, *nephrite* (or *nephrite jade*), and less commonly, the pyroxene-type, *jadeitite* (or *jadeite jade*). New Zealand 'greenstone', or pounamu, is a jade of the nephrite type. It occurs in several limited geographic 'fields' (Beck, 2002), and there is considerable interest in determining characteristics that identify its source, for example when found not *in situ*, or where traded for cultural and commercial reasons. The geographic 'fields' fall within different geological (tectonostratigraphic) terranes (Fig. 1), suggesting that nephrites might inherit a distinctive signature, in terms of age or radiogenic isotopic composition, from their terrane hosts. In this study, we report Rb–Sr age and Sr-isotope data obtained from New Zealand nephrites, and their host rocks, to ascertain whether they have a distinctive age-isotopic signature. This is of considerable petrogenetic importance, and

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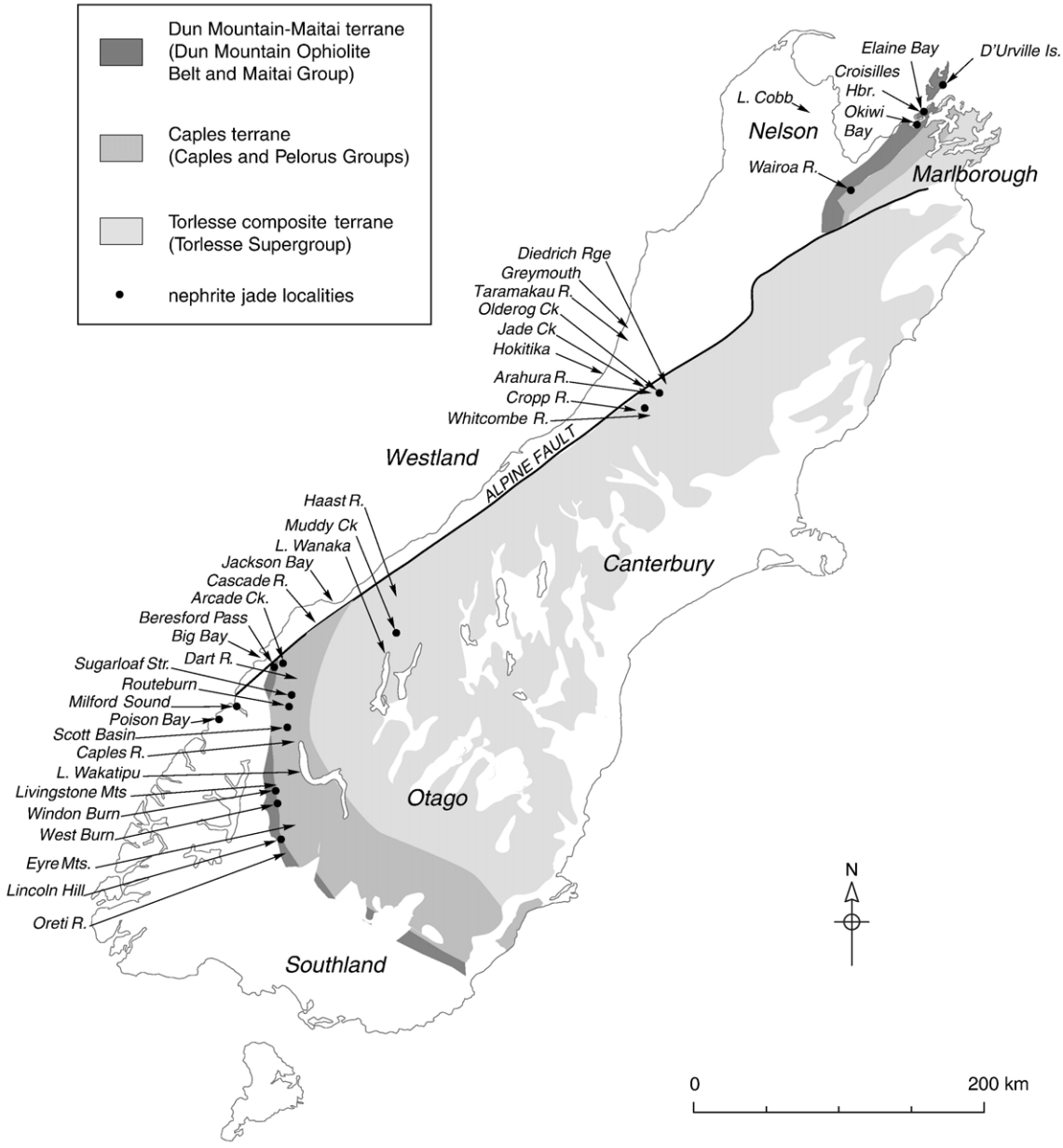

Fig. 1. Geological basement terrane outcrop map of New Zealand, showing nephrite sample and other locations discussed in the text.

would be a useful characteristic in establishing the geological source of jades not seen *in situ*.

2. Features, compositions and occurrence of jades

Nephrite jade normally comprises >99% microcrystalline amphibole, generally in the tremolite–actinolite series but, with high quality, close to tremolite [$Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$]. However, the quality of this jade, in particular its toughness, is dependent on the development of a distinctive, interwoven felted tremolite fabric. There is thus little potential variation in major element composition, either amongst nephrites at any one locality, or between unrelated localities around the world. The specialist can recognise particular features in jades from different 'fields', for example, in terms of texture, colour and inclusions, but these features are not necessarily distinctive. There have been attempts to