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Trace element features of hydrothermal and inherited igneous zircon grains in mantle wedge environment: A case study from the Myanmar jadeitite

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ABSTRACT

Jadeitites are considered to crystallise in ultramafic rocks in the subduction channel presumably from the overlying mantle wedge, and therefore zircons from these rocks provide important insights into mantle wedge processes. Here we investigate hydrothermal zircon (Group II) formed within a subduction zone and compare these with the igneous zircon cores (Group I) from the Myanmar jadeitite. Previous U–Pb studies reported ages of Groups I and II zircons as ~163 Ma, and ~147 Ma respectively, and both show isotope signature of the depleted mantle. Group I zircons have much higher total concentrations of rare earth elements (REEs) (500–1945 ppm) than those of Group II zircon (112–307 ppm), and contains relatively higher abundance of Y, Nb, Ta, Ti, Th and U with higher $(Sm/La)_N$ ratios (25.3–501) and Ce-anomalies (8.04–140) but lower $(Yb/Gd)_N$ ratios (9.76–57.0) than those of the Group II ($(Sm/La)_N$ ratios = 2.12–32.2, Ce-anomalies = 1.63–19.6, $(Yb/Gd)_N$ ratios = 44.8–142). Hf concentrations are broadly similar in both Groups. The Group I zircons are considered to be magmatic and crystallised from H_2O–rich basaltic melt at relatively high pressure in the mantle wedge, whereas the Group II zircon overgrowth took place through recrystallisation and precipitation with distinct dissolution of the Group I zircons. Variation in the concentration of trace elements in zircons from Groups I to II in the mantle wedge is related to an intra-oceanic subduction system in the presence of Na-rich hydrothermal fluids under high-pressure and low-temperature. The Ti-in-zircon thermometer yield a mean crystallisation temperature of 742 ± 141 °C for Group I zircons, whereas the Group II zircons yield 339 ± 33 °C. The two groups of zircons also provide insights into the probable protolith involved in formation of the Myanmar jadeitite.

1. Introduction

Zircon is a common accessory mineral in a variety of rocks formed in various tectonic settings, and is stable over a broad range of temperatures and pressures (Bingen et al., 2001; Hoskin and Schaltegger, 2003). Its high durability and resistance to various geological processes such as erosion and transportation, sluggish intracrystalline diffusion (Watson and Cherniak, 2003), as well as the capacity to host trace elements and isotopes especially U, Th, Pb, Hf, Ti, and Li, rare earth element (REE) and O (e.g. Cherniak and Watson, 2007; Hoskin and Schaltegger, 2003; Page et al., 2007; Ushikubo et al., 2008) make it an important recorder for various geochemical, isotopic and geochronological investigations. Furthermore, growth zones within single grains of zircon often record distinct geological events (e.g. Belousova et al., 2006; Shi et al., 2008; Chen et al., 2010; Flores et al., 2013). Studies of inclusions, growth patterns, isotopes and trace elements in different zircon domains are useful tools to decipher the history of the host rocks and thermal events. Thus, zircon has been widely used for evaluating petrogenesis, geochronology and tectonics (e.g. Jiang et al., 2012; Liu et al., 2010, 2015, 2016; Sánchez-Rodriguez and Gebauer, 2000; Yang et al., 2016).

Jadeitite, a rare rock composed mainly of jadeite, is typically found in serpentinite in close spatial association with high-pressure/low-temperature (HP-LT) metamorphic rocks such as blueschist and eclogite. Several occurrences of jadeitite have been reported from Phanerozoic orogenic belts such as Alps-Himalayan, circum-Pacific, Caribbean and Caledonian regions (e.g. Compagnoni et al., 2007; Garcia-Casco et al., 2009; Harlow et al., 2007, 2011, 2012, 2015, 2016; Morishita et al., 2007; Schertl et al., 2012; Shi et al., 2001, 2008; Shigeno et al., 2012; Tsujimori et al., 2005; Usui et al., 2006), along with jadeitite xenoliths in serpentinised ultramafic microbreccias (Tsujimori and Harlow, 2012). Jadeitite has been interpreted by Tsujimori and Harlow

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(2012) as P-type, which precipitated directly from subduction-zone hydrous fluids (Harlow and Sorensen, 2005; Morishita et al., 2007; Shi et al., 2005b; Sorensen et al., 2006) or as R-type, which formed through metasomatic replacement of a protolith by subduction-zone fluid–rock interaction (Compagnoni et al., 2007; Mori et al., 2011; Ng et al., 2016; Shigeno et al., 2005; Wang et al., 2012; Yi et al., 2006) in ultramafic rocks of the mantle wedge overlying subduction systems. In both types, zircon occurs as an accessory mineral within jadeitite or jadeitised omphacitite and rodingite (e.g., Ng et al., 2016; Wang et al., 2012; Yi et al., 2006).

Zircon in the jadeitite from several localities worldwide can be grouped into two types based on their growth textures under cathodoluminescence imaging and mineral inclusions as: igneous/core (Group I) and hydrothermal/rim (Group II or/and III) (e.g. Mori et al., 2011; Shi et al., 2008; Yui et al., 2013). In the investigation of Myanmar jadeitite by Shi et al. (2008), two main groups of zircons (Groups I and II) were distinguished based on their mineral inclusions, growth texture, and SHRIMP U–Pb age, with minor Group III zircon considered to mark a later stage hydrothermal event. Recently, Yui et al. (2013) reported three Groups of zircons in one sample (BUR Z1),

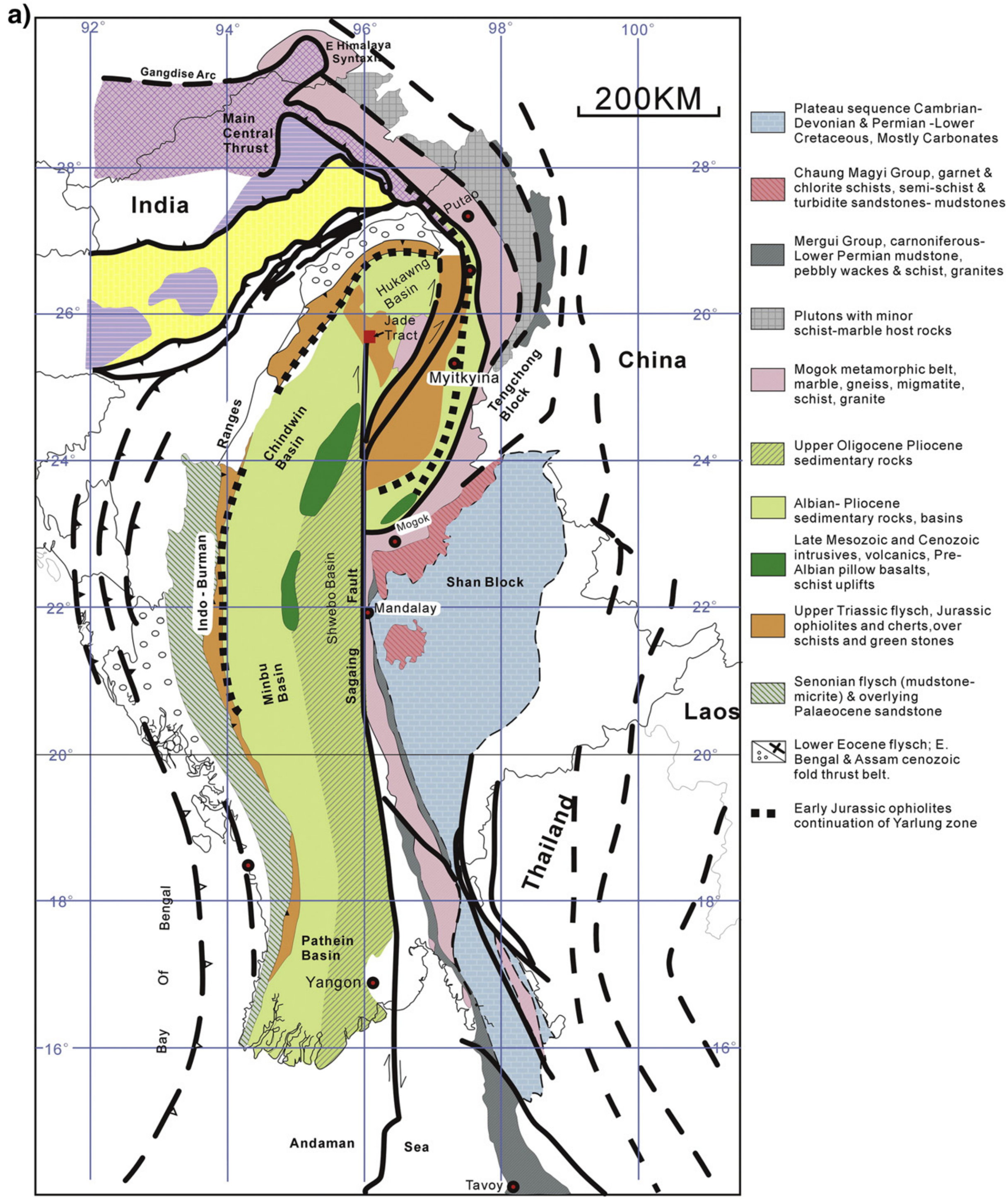

Fig. 1. (a) Geological framework of Myanmar, showing the jade Mine Tract. (b) Geological sketch map of the Myanmar Jade Mine Tract.
(Modified after Bender, 1983 and Morley, 2004)