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Is Myanmar jadeitite of Jurassic age? A result from incompletely recrystallized inherited zircon

Tzen-Fu Yui [a,*], Mayuko Fukoyama [a,b], Yoshiyuki Iizuka [a], Chao-Ming Wu [c], Tsai-Way Wu [d], J.G. Liou [e], Marty Grove [e]

[a] Institute of Earth Sciences, Academia Sinica, Taipei, 11529, Taiwan, ROC
[b] Graduate School of Engineering and Resource Science, Akita University, Japan
[c] Department of Applied Arts, Fu-jen Catholic University, Hsinchuang, Taiwan, ROC
[d] Department of Earth Sciences, University of Western Ontario, London, Ontario, Canada
[e] Department of Geological and Environmental Sciences, Stanford University, Stanford, CA 94305, USA

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ABSTRACT

Zircons from two Myanmar jadeitite samples were separated for texture, mineral inclusion, U–Pb dating and trace element composition analyses. Three types of zircons, with respect to U–Pb isotope system, were recognized. Type I zircons are inherited ones, yielding an igneous protolith age of 160 ± 1 Ma; Type II zircons are metasomatic/hydrothermal ones, giving a (minimum) jadeitite formation age of 77 ± 3 Ma; and Type III zircons are incompletely recrystallized ones, with non-coherent and geologically meaningless ages from 153 to 105 Ma. These Myanmar jadeitites would therefore have formed through whole-sale metasomatic replacement processes.

Compared with Type I zircons, Type II zircons show typical metasomatic/hydrothermal geochemical signatures, with low Th/U ratio (<0.1), small Ce anomaly ($Ce/Ce^* = <5$) and low ΣREE content (40–115 ppm). Type III zircons, however, commonly have the above geochemical signatures straddle in between Type I and Type II zircons. It is shown that the resetting rates of various trace element compositions and U–Pb isotope system of inherited zircons are not coupled "in phase" in response to zircon recrystallization during jadeitite formation. The observed abnormally low Th/U ratio and small Ce anomaly of some Type I zircons, as well as the lack of negative Eu anomaly of all Type I zircons, should be suspected to be of secondary origin. In extreme cases, incompletely recrystallized zircons may show typical metasomatic/hydrothermal geochemical signatures, but leave U–Pb isotope system partially reset or even largely unchanged. Such zircons easily lead to incorrect age interpretation, and hence erroneous geological implication.

The Myanmar jadeitites, based on the present study, might have formed during the Late Cretaceous subduction before the beginning of India–Asia continental collision at Paleocene. Previously proposed Late Jurassic ages for Myanmar jadeitites are suggested as results rooted on data retrieved from incompletely recrystallized inherited zircons.

1. Introduction

Jadeitite is an uncommon rock type often associated with eclogite and blueschist in high-pressure metamorphic belts around the world. It is a fluid–rock interaction product enclosed within serpentinite formed under subduction environments (e.g., Harlow and Sorensen, 2005; Harlow et al., 2007). The formation mechanism(s) of jadeitites would thus reveal important clues on element migration/cycling during subduction and the age of jadeitite, theoretically, would provide useful time constraints for regional tectonics (see Tsujimori and Harlow, 2012 and the references therein; Flores et al., 2012; Yui et al., 2012).

There are two possible formation mechanisms for jadeitite, which, accordingly, can be divided into two types. The "vein precipitation type" or the "P-type" jadeitite is formed through direct precipitation from a Na–Al–Si-rich aqueous fluid infiltrating through serpentinites and the "metasomatic replacement type" or the "R-type" jadeitite is formed through whole-sale metasomatic replacement of (igneous) tectonic blocks within serpentinites (Tsujimori and Harlow, 2012; Yui et al., 2010). Zircons in jadeitite may therefore be either recrystallized/newly-formed contemporaneous with jadeite formation, or inherited from protoliths. As a result, U–Pb dating of such zircons would theoretically yield the jadeitite age or the protolith igneous age, respectively. However, since both types of jadeitite may share similar characteristics, it may not be easy to confidently categorize a specific

* Corresponding author at: Institute of Earth Sciences, Academia Sinica, Taipei, 11529, Taiwan, ROC. Tel.: +886 2 27839910x621; fax: +886 2 27839871.
E-mail address: tfyui@earth.sinica.edu.tw (T.-F. Yui).

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jadeitite sample in question. Furthermore, the lack of clear-cut criteria to discriminate igneous zircons from hydrothermal/metamorphic ones has also been noted recently (e.g., Bulle et al., 2010; Harley et al., 2007), not to mention the potential problems with respect to incomplete recrystallization of inherited zircons during jadeitite formation. Controversial suggestions on the geological meaning of the U–Pb dating results of zircons from a specific jadeitite occurrence (i.e., protolith igneous age or metasomatic/hydrothermal jadeitite age) have therefore been proposed even with the information on internal textures, mineral/fluid inclusions, Th/U ratio, trace-element characteristics, and O-isotope composition of zircons (Bröcker and Keasling, 2006; Bulle et al., 2010; Fu et al., 2010, 2012; Tsujimori et al., 2005).

The Jade Mine Tract in northern Myanmar, located at the northern extremity of the Sagaing fault in the Hpakan area of the Kachin State, is the most famous jadeitite resource in Asia. Recent U–Pb zircon dating studies suggested that these jadeitites might have formed during the Late Jurassic time (Qiu et al., 2009; Shi et al., 2008). In this study, SHRIMP U–Pb dating results on zircons with complicated internal textures from two Myanmar jadeitite samples are presented. The data clearly demonstrate that any interpretation on jadeitite U–Pb zircon ages must be regarded with caution.

2. Geological background

Geologically, Myanmar (Burma) can be divided into the Western province and the Eastern province, separated by the Sagaing fault (Fig. 1). The Western province is also named as the Burma microplate, whereas the Eastern province is part of the Shan-Thai block. The east dipping Andaman subduction zone that continues onshore along the western margin of the Western province (the Burma microplate) marks the presently active boundary with Indian plate to the west. The Sukhotai-Lao fold belt and the Nan-Uttaradit suture denote the

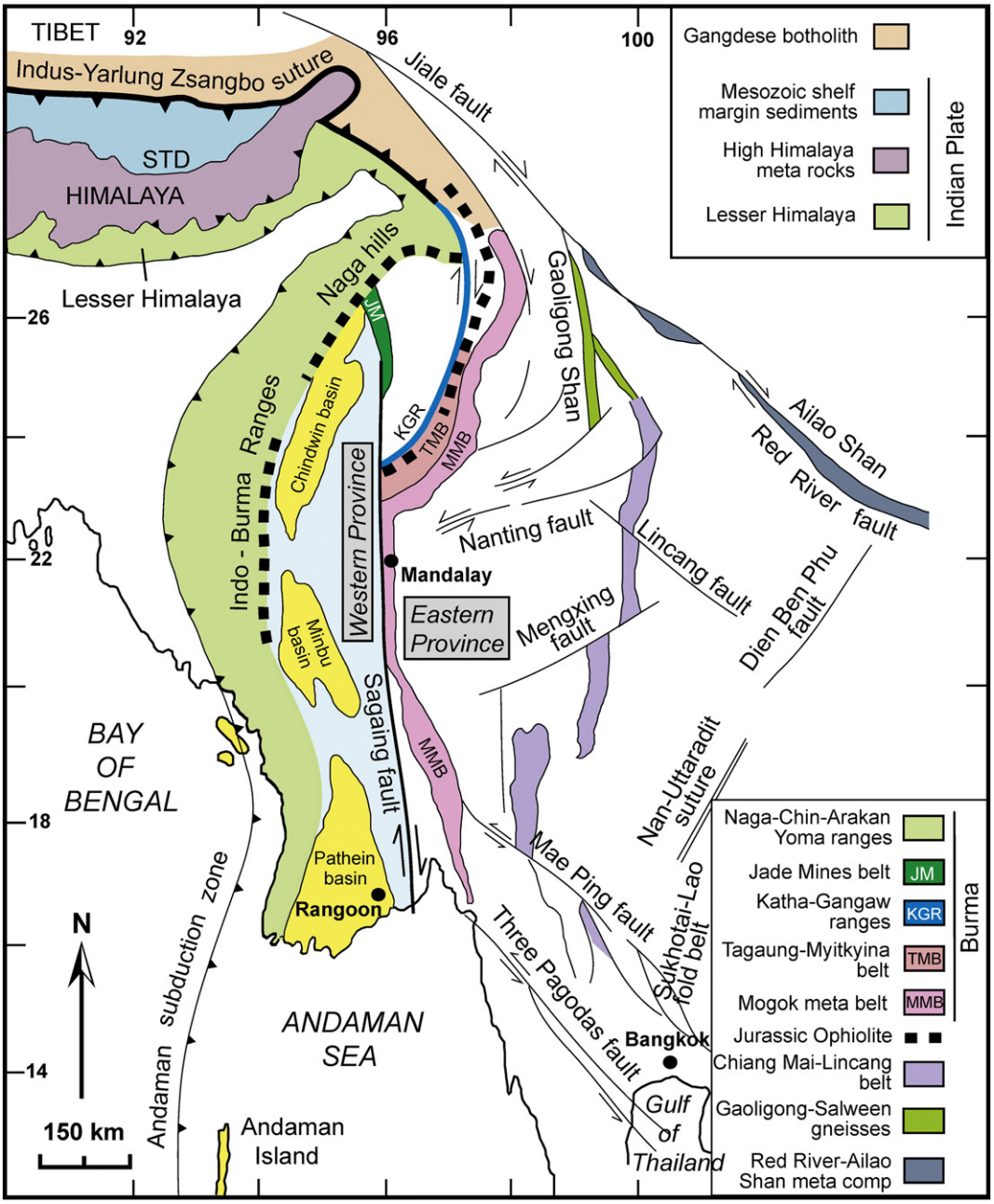

Fig. 1. Geologic overview of the Myanmar area (modified after Searle et al., 2007). Samples in the present study are from the Hpakan area of the Jade Mines belt. STD: South Tibet Detachment.