Lithos 246–247 (2016) 31–47

Contents lists available at ScienceDirect

Lithos

journal homepage: www.elsevier.com/locate/lithos

A small Archaean belt — diverse age ensemble: A U–Pb study of the Tipasjärvi greenstone belt, Karelia Province, central Fennoscandian Shield, Finland

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ARTICLE INFO

Article history:
Received 10 June 2015
Accepted 1 November 2015
Available online 18 December 2015

Keywords:
Absolute age
Archaean
Chronostratigraphy
Karelia
Greenstone belt
U–Pb

ABSTRACT

The Archaean Tipasjärvi greenstone belt is a small area (ca. 5 × 25 km) located within the Karelia Province in Central Fennoscandian Shield, Finland. The belt forms the southernmost part of the larger Archaean Suomussalmi–Kuhmo–Tipasjärvi greenstone complex. The present study results for this site are based on zircon grains of 12 metavolcanic and metasedimentary rock samples that were studied with the single-grain secondary ion mass spectrometry (SIMS) U–Pb method. Our data indicate that the volcanism in the belt took place over three separate episodes: ca. 2.84 Ga, 2.82 Ga and 2.80 Ga. The oldest volcanic rocks are older than the oldest dated tonalitic pluton adjacent to the belt. The main geochemical characteristics of the samples reveal that the felsic volcanic rocks of the different age groups resembled each other. However, contrasting trace element geochemical characteristics between the different age groups are also distinguishable. The detrital zircon record agrees with previous observations indicating that the sediments accumulated at least 50 Myr after the formation of the youngest volcanic rocks. During sediment deposition, older crustal material (>3.0 Ga) was exposed within the source area. The geochronological results in this study enable us to update the chronostratigraphic interpretation of the Tipasjärvi greenstone belt and to compare these results to those from other parts of the Archaean Suomussalmi–Kuhmo–Tipasjärvi greenstone complex and adjacent tonalitic plutons.

1. Introduction

Archaean greenstone belts are important pieces of crust that preserve the supracrustal sequences of the early Earth (Condie, 1994). The relationship between the greenstone belts and the surrounding plutonic and/or (high-grade) metamorphic rocks is a key factor in evaluating the tectonic settings during which the greenstone belts formed. Van Kranendok (2004) concluded that generalising about whether the Archaean greenstone belts are autochthonous or allochthonous is impossible. Answering this question will therefore require the accurate determination of the geochronology of the surrounding granitoids and of the volcanic rocks of the greenstone belts themselves. Unravelling the relationships between individual volcanic and sedimentary sequences is subject to important constraints, especially when discussing the tectonic setting in which the supracrustal rocks formed.

The Tipasjärvi greenstone belt (Fig. 1) in eastern Finland forms the southernmost tip of the Archaean Suomussalmi–Kuhmo–Tipasjärvi greenstone complex. Previously, Luukkonen (1991) and Papunen et al. (2009) used an intra-continental rift model to explain the genesis of the supracrustal sequences of the Tipasjärvi greenstone belt. The intra-continental rift model has since been challenged, however, because radiogenic isotope data suggest that the contribution of older crustal material in the genesis of the greenstone belt was insignificant (Huhma et al., 2012a, 2012b). Moreover, Maier et al. (2013) concluded that the komatiites in the Suomussalmi–Kuhmo–Tipasjärvi greenstone complex formed in diverse palaeoenvironments, as revealed by, for example, ratio plots of immobile trace elements (Zr/Nb, Nb/Th, Nb/Y, Zr/Y), where komatiitic rocks from the Tipasjärvi and Kuhmo greenstone belts show mainly oceanic plateau affinity, and komatiitic rocks from the Suomussalmi greenstone belt show mainly mid-ocean ridge basalt and arc affinities and Maier et al. (2013) suggested a continental rift setting for those.

Previously, age data from five rock samples of both volcanic and sedimentary origin were obtained from the Tipasjärvi belt with the thermal ionisation mass spectrometry (TIMS) and laser ablation multi-collector inductively coupled mass spectrometer (LA-ICP-MS) U–Pb zircon methods (Huhma et al., 2012a; Vaasjoki et al., 1999).

In this study we present new geochronological data analysed with the single zircon grain secondary ion mass spectrometry (SIMS) method for nine new samples and three previously analysed

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http://dx.doi.org/10.1016/j.lithos.2015.11.008
0024-4937/

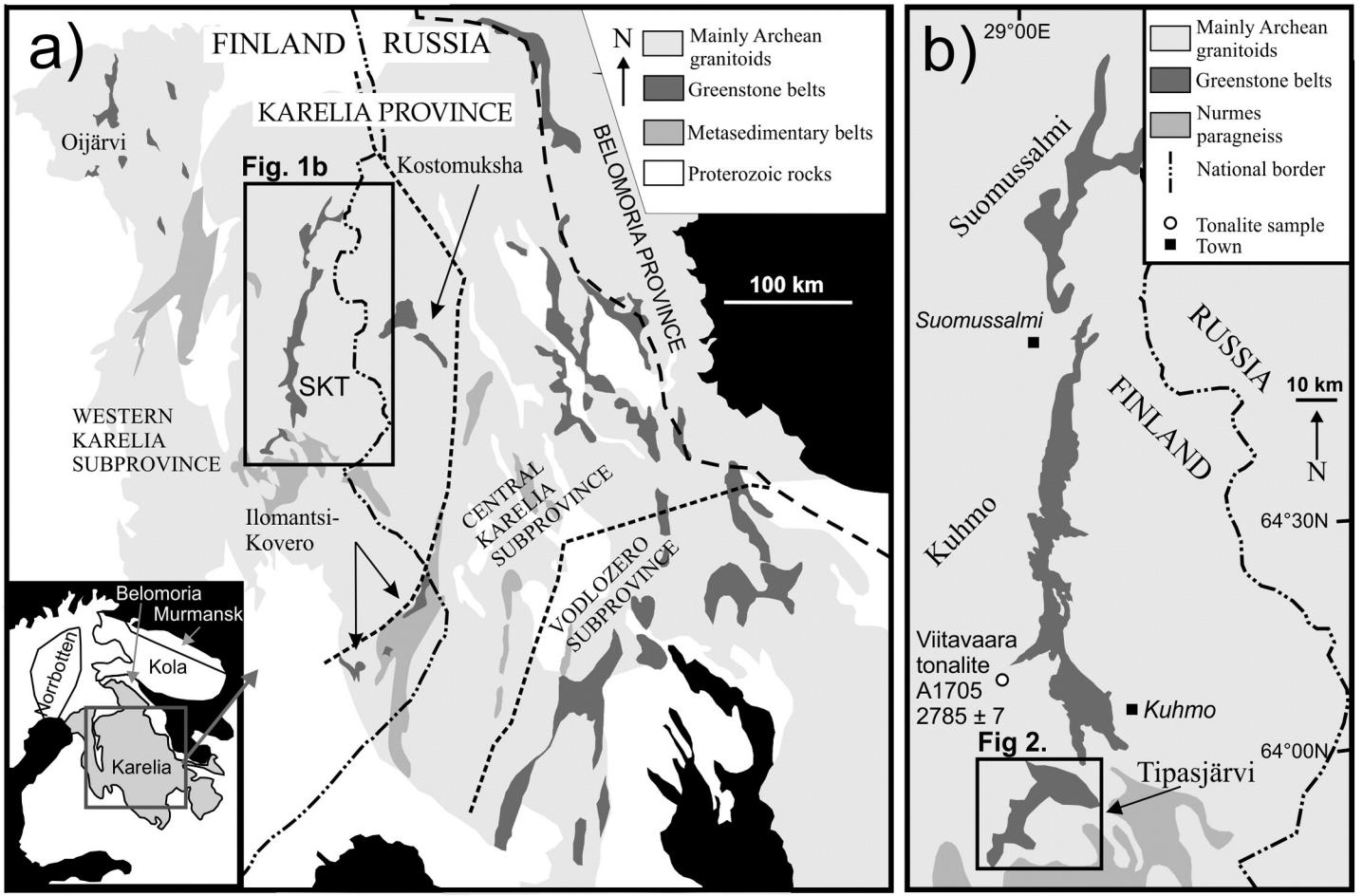

Fig. 1. Simplified lithological maps of a) the Karelia Province and b) the Suomussalmi–Kuhmo–Tipasjärvi area. Age data in 1b are from Käpyaho et al. (2006). Maps adapted from Korsman et al. (1997).