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The age of the North Asian Cratonic basement: An overview

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Abstract

The North Asian Craton is the largest Precambrian continental fragment in the present-day geologic mosaic of Asia. It includes a basement comprising an ancient platform surrounded by orogenic belts and is largely overlain by Late Precambrian, Paleozoic, and Mesozoic sedimentary cover rocks. Recently, a large number (~400) of isotopic dates from metamorphic rocks have been generated and this paper summarizes these data together with new geological information on the composition and age of the metamorphic terranes comprising the basement. An evolutionary model of the North Asian Craton is presented which shows that the basement is composed of Archean (55.0%), undifferentiated Archean and Paleoproterozoic (13.0%), Paleoproterozoic (20.0%) and Mesoproterozoic (12.0%) terranes. A consistent eastward and southward younging of terranes is observed from the Neoarchean Tunguska and West Aldan terranes, suggesting that crust-forming processes were most extensive in the Neoarchean. The basement of the Verkhoyansk fold-and-trust Belt is composed of Mesoproterozoic crystalline complexes with a metamorphic age of 1.0 to 0.9 Ga.

Keywords: Archean; Proterozoic; Precambrian; North Asian Craton; Precambrian crustal evolution; Siberian Platform; Geochronology

1. Introduction

The North Asian Craton is the largest Precambrian continental fragment comprising the present-day Asia and is largely covered by Late Precambrian, Paleozoic, and Mesozoic sedimentary rocks of the Siberian Platform (Fig. 1). Along its edges are the Verkhoyansk, Baikal-Patom and Southern Taymir fold-and-thrust belts and the Near Sayan, Akitkan and Olenek uplifts (Nokleberg et al., 2003). The fold-and-thrust belts are separated from the platform by frontal thrusts. Windows of the basement underlying the Siberian Platform comprise the Aldan–Stanovoy and Anabar shields.

The basement of the North Asian Craton represents a collage of terranes composed mainly of granulite and amphibolite facies metamorphic rocks (Rosen et al., 1994; Smelov et al., 1998). Although a large body of research has been undertaken, many of the key problems concerning geology and petrology of Precambrian metamorphic and magmatic rocks of the basement have remained unresolved. The main reason for this situation was that until recently, no reliable geochronological and isotope-geochemical data were available. However, over 400 isotopic age determinations have recently obtained by a variety of methods (Kovach et al., 1995a,b; Smelov et al., 1998; Kovach et al., 2000; Rosen, 2002; etc.). These data have allowed refined tectonic models for the basement evolution to be developed (Rosen et al., 1994; Frost et al., 1998) and models for the position of the North Asian Craton within proposed Precambrian supercontinents can now be tested with better precision. These issues have been addressed within the project "Mineral Resources, Metallogenesis, and Tectonics of North-east Asia" (Nokleberg et al., 2003). In this paper the new data from Russia are used to construct an internally consistent model for the geodynamic evolution of the basement to the North Asian Craton.

2. Methods

The authors employ the technique of terrane analysis as proposed by Coney et al. (1980). Terrane analysis requires the following steps: (1) the recognition of terranes, their overlap units (sedimentary and volcanic-sedimentary) and "stitching"

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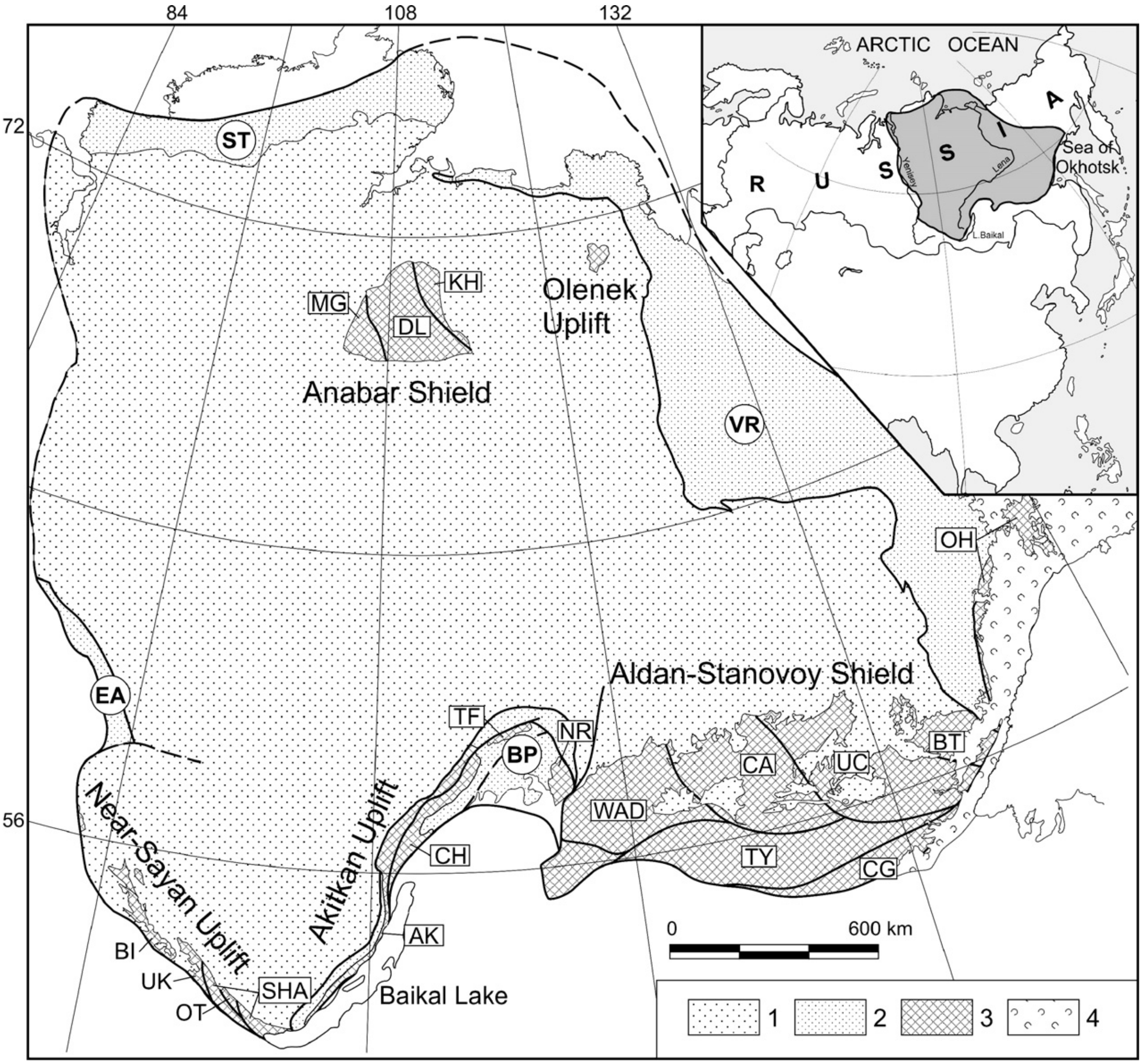

Fig. 1. Tectonic scheme of the North Asian Craton. 1 — ancient platform, 2 — subsided craton margin-fold-and-thrust belt (ST = South Taimyr, EA = East Angara, BP = Baikal-Patom, VR = Verkhoyansk), 3 — shields and uplifts (Precambrian terranes are coded: West Aldan (WAD), Central Aldan (CA), Uchur (UC), Batomga (BT), Chogar (CG), Tynda (TY), Daldyn (DL), Khapchan (KH), Magan (MG), Akitkan (AK), Chuja (CH), Nechera (NR), Tonod (TF), Sharizhalgay (SHA), Onot (OT), Urik-Lay (UK), Biryusa (BI)), 4 — Mesozoic volcano-plutonic belt. Inset shows location of the region.

assemblages (magmatic and metamorphic); (2) the definition of terrane boundaries and types (thrust, strike–slip, or normal fault); (3) the genetic classification of terranes and their overlap and "stitching" assemblages on an actualistic basis (e.g. island-arc formations, accretionary wedge complexes, active and passive continental margin sequences, fragments of oceanic crust, etc., and magmatic formations related to rifting, collision, subduction, and other processes); (4) the recognition and classification of post-accretionary faults formed after accretion of the terranes to a continental margin and of tectonic displacements responsible for dismembering and dispersion of terranes; and (5) the analysis of paleobiogeographic and paleomagnetic data that clarify the signature of the terranes and help to identify their origin (Parfenov et al., 1998).

Early Precambrian structures preserved in the basement of cratons and exposed in windows or shield nuclei (Fig. 1), represent a mosaic of blocks up to hundreds of kilometers across that are separated and surrounded by linear folded belts metamorphosed to varying degrees, in some cases up to granulite facies. For the purposes of this analysis we consider that the terranes comprising Early Precambrian cratons should be defined and described in the same way as is in Phanerozoic orogenic belts. They are typically linear fault-bounded tectonic units, tens to a few hundreds of kilometers across with contrasting geologic histories that can be classified on the basis of their rock composition, such as granite–greenstone, granulite–orthogneiss, tonalite–trondhjemite gneiss, granulite–paragneiss, paragneiss, etc. The terranes are separated by faults zones or tectonic mélange zones (collisional sutures). Within these mélange zones slivers of rocks from adjacent terranes and high-pressure granulites from the lower crust levels may be tectonically juxtaposed. All these rocks may have undergone