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Circum-Arctic lithosphere-basin evolution: An overview

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ABSTRACT

A new collection of papers spanning the breadth of the Arctic provides new insight into the region's geodynamic evolution. New results pertain to lithospheric structure, the link between magmatic and extension-related tectonic processes, variations in the composition and velocity structure of the lower crust in the Amerasia Basin, and provenance and paleogeography of Paleozoic to Triassic successions across the Arctic. Elucidation of geodynamic processes in the Eurasia Basin suggests new hypotheses for future research in the complex and poorly understood Amerasia Basin. New results from detrital zircon provenance studies as well as from stratigraphic facies compilations constrain the Late Paleozoic to Triassic paleogeography of the Arctic realm.

1. Introduction

This circum-Arctic lithosphere-basin Special Issue evolved from a Special Session at the Geological Society of America Annual meeting in Vancouver, Canada in 2014. The session's aim was to highlight new research across the Arctic, reflecting the breadth of lithospheric interactions that occurred over the past ~700 Myr, emphasizing thematic linkages, such as inter-regional, onshore-offshore, lithosphere-basin, magmatism-tectonism and so on. The modern Arctic is the product of a long history of plate tectonic processes that closed and opened Phanerozoic oceans, deformed sedimentary basins and created orogens, together with surface processes that produced and transported sediments from orogenic highlands into adjacent sedimentary basins. By assembling a multidisciplinary suite of papers into one Special Issue, this project attempts to facilitate greater understanding of the interdependence of the processes underlying the tectonic, magmatic and sedimentary evolution of the Arctic, to encourage new avenues for future multidisciplinary studies, and possibly to foster fresh insights into the linkages between these processes.

From the 1960s and until the 1990s, geoscientific research in the Arctic was driven largely by cyclical activity in the petroleum exploration sector, interspersed with intermittent public sector and academic programs. The Arctic's remoteness and inaccessibility were, and continue to be, an impediment to research. Although these efforts resulted in many important advances in understanding the region's geological history, it remained poorly understood. Over the past 10–15 years, the evolution of the Arctic has been increasingly a focus of geoscience research. Initially, this was driven by renewed exploration investments by the petroleum sector. However, as technological advances in petroleum production reduced the economic incentive for Arctic resource development, a new incentive for research arose in the United Nations' 1982 Convention on the Law of the Sea (UNCLOS), Article 76, which sets out how coastal states define the outer limits of their legally defined continental shelf beyond 200 NM, where one exists (e.g., United Nations, 1999). The criteria set out in Article 76 required coastal states to collect significant volumes of bathymetric and sediment thickness data across the Arctic continental margins, which provided an opportunity to acquire new crustal structure data. It was also a challenge to drive new technologies (e.g., new seismic sources designed to operate in heavy ice conditions), data collection methods (e.g., multi-national, multi-ship ice-breaker operations) and international collaborations in order to be successful. Data for several of the contributions to this Special Issue were acquired through surveys in support of programs to define nations' extended continental shelves, as required under Article 76 of the Convention.

Meanwhile, onshore, a dramatic increase in the volume of research based on U-Pb age analyses of detrital zircon began to provide new insights into the provenance histories of multiple Paleozoic and Mesozoic depositional systems around the Arctic. In many cases, they identified previously unrealized common sources for sands deposited into sedimentary basins that were subsequently tectonically dismembered and dispersed. In a few cases, age populations occur for which no plausible sources are known. Further, as the technique has become more widespread, it is increasingly apparent that sedimentary recycling is more common than previously understood. Thus, the immediate zircon sources may be quite different from the original magmatic sources. Such cycles of inheritance can be traced back through several

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generations. In combination with stratigraphic and structural analyses, the use of detrital zircon geochronology continues to advance our understanding of Arctic paleogeography across the region and throughout the Phanerozoic. Three contributions in this issue are based on detrital zircon geochronology.

2. Thematic overview

Altogether, the contributions in this Special Issue reflect current research in the Arctic realm encompassing multiple aspects of the geosciences: lithospheric structure, magmatic processes, rheology,

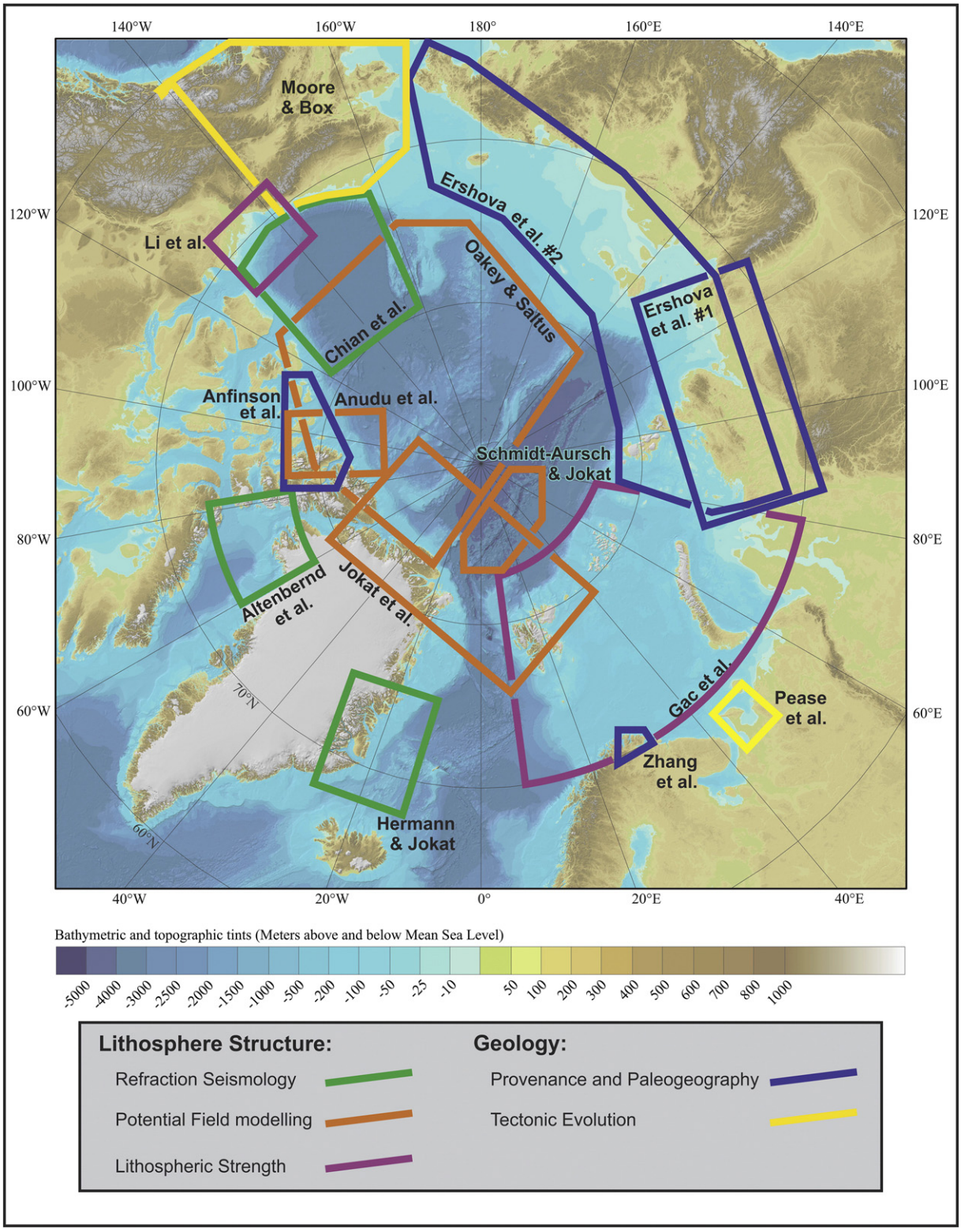

Fig. 1. Summary map showing the areal coverage of papers in this Special Issue. Outlines are colour coded to correspond to the themes and topics outlined in the overview. Bathymetric base map, IBCAO v3 is from Jakobsson et al. (2012).