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Paleomagnetism of the Late Cretaceous ignimbrite from the Okhotsk-Chukotka Volcanic Belt, Kolyma-Omolon Composite Terrane: Tectonic implications

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ABSTRACT

New Late Cretaceous paleomagnetic results from the Okhotsk-Chukotka Volcanic Belt in the Kolyma-Omolon Composite Terrane yield stable and consistent remanent directions. The Late Cretaceous (86–81 Ma) ignimbrites from the Kholchan and Ola suites were sampled at 19 sites in the Magadan area (60.4° N, 151.0° E). We isolated the characteristic paleomagnetic directions from 16 sampled sites using an alternating field demagnetization procedure. The primary nature of these directions is ascertained by dual polarities and positive fold tests. A tilt-corrected mean direction ($D = 42.8°$, $I = 84.7°$, $k = 46.0$, $\alpha_{95} = 10.0°$) yields a paleomagnetic pole of 66.7° N, 168.5° E ($A_{95} = 18.8°$) which appears almost identical to the 90–67 Ma pole reported from the Lake El'gygytgyn area of the Okhotsk-Chukotka Volcanic Belt (Chukotka Terrane). This consistency suggests that the Kolyma-Omolon Composite Terrane and Chukotka Terrane has acted as a single tectonic unit since 80 Ma without any significant internal deformation. Accordingly, we calculate a combined 80 Ma characteristic paleomagnetic pole (Long. = 164.7° E, Lat. = 68.0°, $A_{95} = 10.9°$, $N = 12$) for the Kolyma-Omolon-Chukotka Block which falls 16.5–17.5° south of the same age poles from Europe and East Asia. We ascribe this discrepancy in pole positions to tectonic activity in the area and infer a southward displacement of 1640 ± 1380 km for the Kolyma-Omolon-Chukotka Block with respect to the North American and Eurasian blocks since 80 Ma; more than 260 km of it is attributed to tectonic displacement in the Arctic Ocean due to the opening of the Canadian Basin.

1. Introduction

The present-day Eurasian Continent is a collage of several continental blocks formed as a consequences of sequential collisions and suturing. As shown in Fig. 1, the northeastern part of this mega continent comprises the Siberian Craton, Kolyma-Omolon Composite Terrane and Chukotka Terrane (Parfenov et al., 2009; Stone et al., 2009). Amalgamation of the Kolyma-Omolon Composite Terrane with Siberia in the Mesozoic has been described as one of the paramount tectonic events in the northeastern part of Eurasia (Parfenov et al., 2009). A boundary between the Kolyma-Omolon Composite Terrane and the Siberian Craton is characterized by prominent topographic features including the 1000 km long "S" shaped Verkhoyansk mountain range and the 1500 km long convex Chersky mountain range. These topographic expressions are analogous to those developed along the India-Asia and NCB-SCB collision zones. Thorough understanding at the scale of the Kolyma-Omolon Composite Terrane is required to elucidate collision tectonics in the northeastern part of Eurasia.

The Okhotsk-Chukotka Volcanic Belt (OCVB) of northeastern Eurasia, which is considered to be one of the largest volcanic

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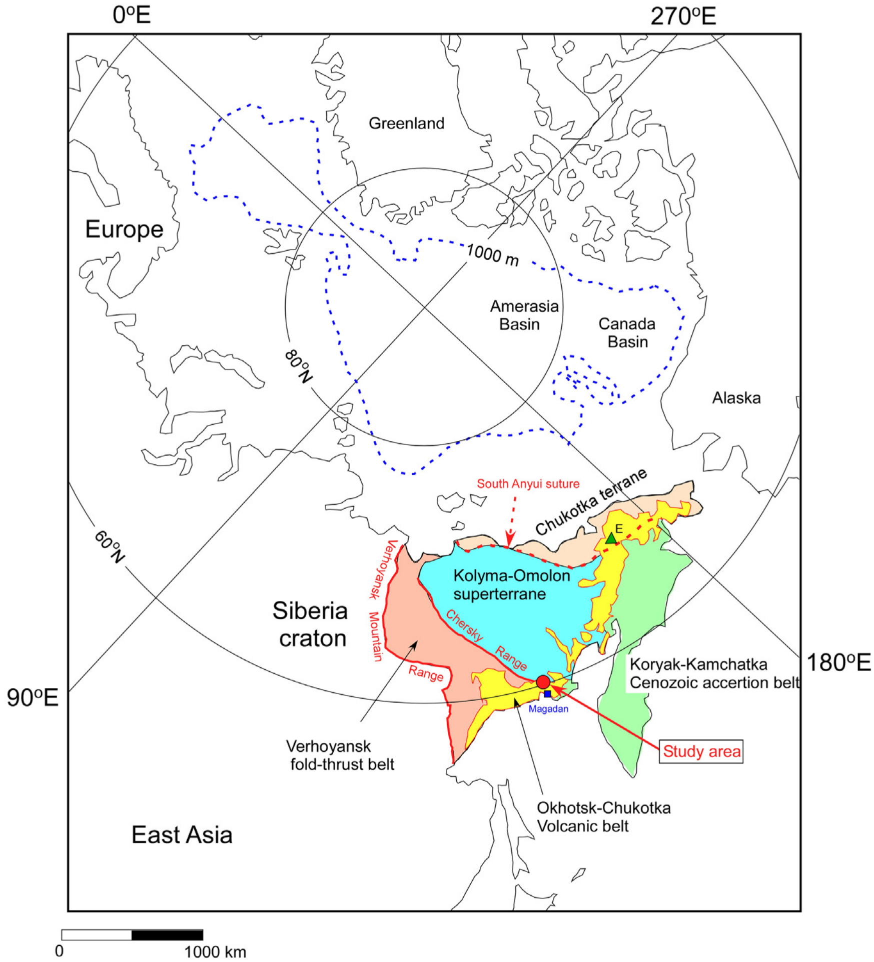

Fig. 1. (a) A simplified tectono-geographical map of the Arctic region. (b) Structural sketch map of the Kolyma-Omolon Composite Terrane and Chukotka Terrane (modified from Stone et al., 2009).

provinces in the world, extends from the Chukotka Terrane in the northeast via Kolyma-Omolon Composite Terrane to the Verhoyansk mountain range. According to some of the recent geological studies (Hourigan and Akinin, 2004; Belyi, 2008; Stone et al., 2009; Sakhno et al., 2010), this belt was formed as a consequences of late Cretaceous volcanic activities. Until a few years ago, some geologists believed that the OCVB is a subduction related belt (Hourigan and Akinin, 2004; Parfenov et al., 2009; Akinin and Miller, 2011). However, Tikhomirov et al. (2012) recently attributed it to silicic igneous province formed in the intra-plate environment. Although the origin of volcanism in this belt remains uncertain, their paleomagnetic signatures can help us to document the Late Mesozoic paleo-geographic framework of the Kolyma-Omolon Composite Terrane and the Chukotka Terrane.

Accordingly this paper presents new paleomagnetic data from the Kolyma-Omolon Composite Terrane because paleomagnetism can provides a quantitative record of block rotation and N-S displacement (Fig. 1). For this purpose we sampled volcanic rocks exposed in the Magadan area (60.4° N, 151.0° E) of the OCVB.

2. Geologic setting

As described by Parfenov et al. (2009) the northeastern part of Eurasia (east of the Siberian Craton) is made up of several terranes; the Verkhoyansk fold and thrust belt, Kolyma-Omolon Composite Terrane, Chukotka Terrane and Koryak-Kamchatka Cenozoic accretionary belt (Fig. 1). These terranes were amalgamated as a result of sequential collisions and accretions during the Mesozoic and Cenozoic. Formation of the Mesozoic Verkhoyansk fold and thrust belt, as a result of the collision of the Siberian Craton with the allochthonous Kolyma-Omolon Composite Terrane, was followed by the Chukotka Terrane accretion (Oxman, 2003). An extensive intra-plate magmatic activity from the Early to Late Cretaceous (from 106 ± 1.7 to 74 ± 1.2 Ma), which brought widespread volcanic emplacement over the Mesozoic assemblages of the Kolyma-Omolon and Chukotka terranes, has been considered to be the cause of OCVB formation (Tikhomirov et al., 2012). The Cenozoic Koryak-Kamchatka accretionary belt formed as a final phase of this sequence.

The Arman volcanic field in the Magadan area forms the central part of the Okhotsk sector in the OCVB (Hourigan and Akinin, 2004). These volcanics were emplaced over deformed sedimentary rocks of the Momoltykich and Khasyn suites deposited in a passive margin back-arc basin (marine environment) from the Permian to the Jurassic. As shown in Fig. 2, the Arman volcanic field is divided into six suites; the Arman, Narauli, Kholchan, Ulyn, Ola and Mygdykit in ascending order (Anorov et al., 2013a,b). Based on floral assemblages (the Arman flora) found in the type area late Albian and Cenomanian ages have been assigned to the Arman volcanic field. The $^{40}Ar/^{39}Ar$ dating assigns an age of 85.5–85.6 Ma to the Narauli Suite, 81.7–83.6 Ma to the Ola Suite and 74.0–78.8 Ma to the Mygdykit Suite. Hence, Late Cretaceous age is assigned to the Arman volcanic field.