Available online at www.sciencedirect.com

ScienceDirect

Journal of Asian Earth Sciences 33 (2008) 1–24

Journal of Asian Earth Sciences

www.elsevier.com/locate/jaes

Evolution of collision-related basins in the eastern end of the Kurile Basin, Okhotsk Sea, Northwestern Pacific

Taqumi TuZino *, Fumitoshi Murakami

Geological Survey of Japan, AIST, Tsukuba 305-8567, Japan

Received 28 November 2006; received in revised form 19 July 2007; accepted 10 September 2007

Abstract

A densely-meshed 9400 km long high-resolution seismic survey revealed the evolution of sedimentary basins in the southeastern rim of the Kurile Basin, offshore of eastern Hokkaido, NW Pacific. Hokkaido is situated in a collision zone not only of Okhotsk and Eurasian plates and also of the Kurile and NE Japan arcs. Offshore eastern Hokkaido is overlain by N–S-trending basins: Hamatonbetu-oki, Monbetu-oki, and Kitami-Yamato Sedimentary Basins (HOSB, MOSB and KYSB, respectively), and Abasiri-oki Trough (AOT), separated by zones of uplift. Depositional patterns of the HOSB and deformation of the adjacent Uplift Zone suggest the pull-apart origin of the basin related to dextral motions along the Central Sakhalin Fault, which extends to Hokkaido and binds the Okhotsk and Eurasian plates. The Uplift Zone adjacent to the MOSB suggests the initiation of subsidence in the Middle Miocene within a splay-fault basin with subsequent transformation into a 40 km wide graben in the Late Miocene and into a half graben in the Pliocene. The pre-late Miocene unconformity is widespread. The KYSB and the AOT began as a concatenated basin in the south of MOSB in the Middle Miocene. In the Pliocene, the Kitami'Yamato Bank (KYB) was uplifted and divided the KYSB–AOT basin into KYSB and AOT. The KYB uplift was probably induced by the Kurile forearc sliver movement. The interpretation of structures suggests that the Kurile Basin may have opened in a N–S-direction, from dextral shearing along a collision zone in the Middle Miocene. In the Pliocene, the kinematics changed to a NE–SE spreading direction; because of southwestward migration of the Kurile Arc with respect to the NE Japan Arc. Compressional tectonics after the Pliocene may suggest the destruction of the Kurile Basin.

Keywords: Backarc; Graben; Inversion; Kurile Basin; Okhotsk; Sakhalin; Splay fault

1. Introduction

Sakhalin and Hokkaido, Northeast Asia, are located along the boundary between the Eurasian and the Okhotsk plates, whose boundary is represented by a N–S-trending dextral shear zone (Fig. 1, Kimura et al., 1983; Zonenshain and Savostin, 1981; Savostin et al., 1983; Jolivet, 1987). The plate boundary features several N–S-trending strike-slip faults cutting through central Hokkaido and Sakhalin, such as the right-lateral Central Sakhalin–Hokkaido Fault (CHS in Fig. 1). This fault has probably been active from the Oligocene (Kimura et al., 1983; Fournier et al., 1994) to the recent (1995 Sakhalin Earthquake; Ivashchenko et al., 1997). The dextral shear possibly induced strike-slip deformation, pull-apart basin formation and the rotation of crustal blocks about vertical axes (Rozhdestvenskiy, 1982; Jolivet, 1987; Worrall et al., 1996). There are two models describing the rotation of fault-bounded 'domino' blocks in Sakhalin and Hokkaido. Fournier et al. (1994) suggested that counter-clockwise rotations would be expected for Neogene basins in eastern areas of Sakhalin. Takeuchi et al. (1999) and Weaver et al. (2003) suggested that clockwise rotations have occurred, accommodated by 100 km scale crustal blocks, which were part of a domino system that may have extended southward to Hokkaido, based on palaeomagnetic data from Hokkaido and Sakhalin. The edges of crustal blocks should be expected to sustain tectonic deformation. Namely, triangular zones

* Corresponding author.
E-mail address: taphonomy@ni.aist.go.jp (T. TuZino).

1367-9120/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jseaes.2007.09.006

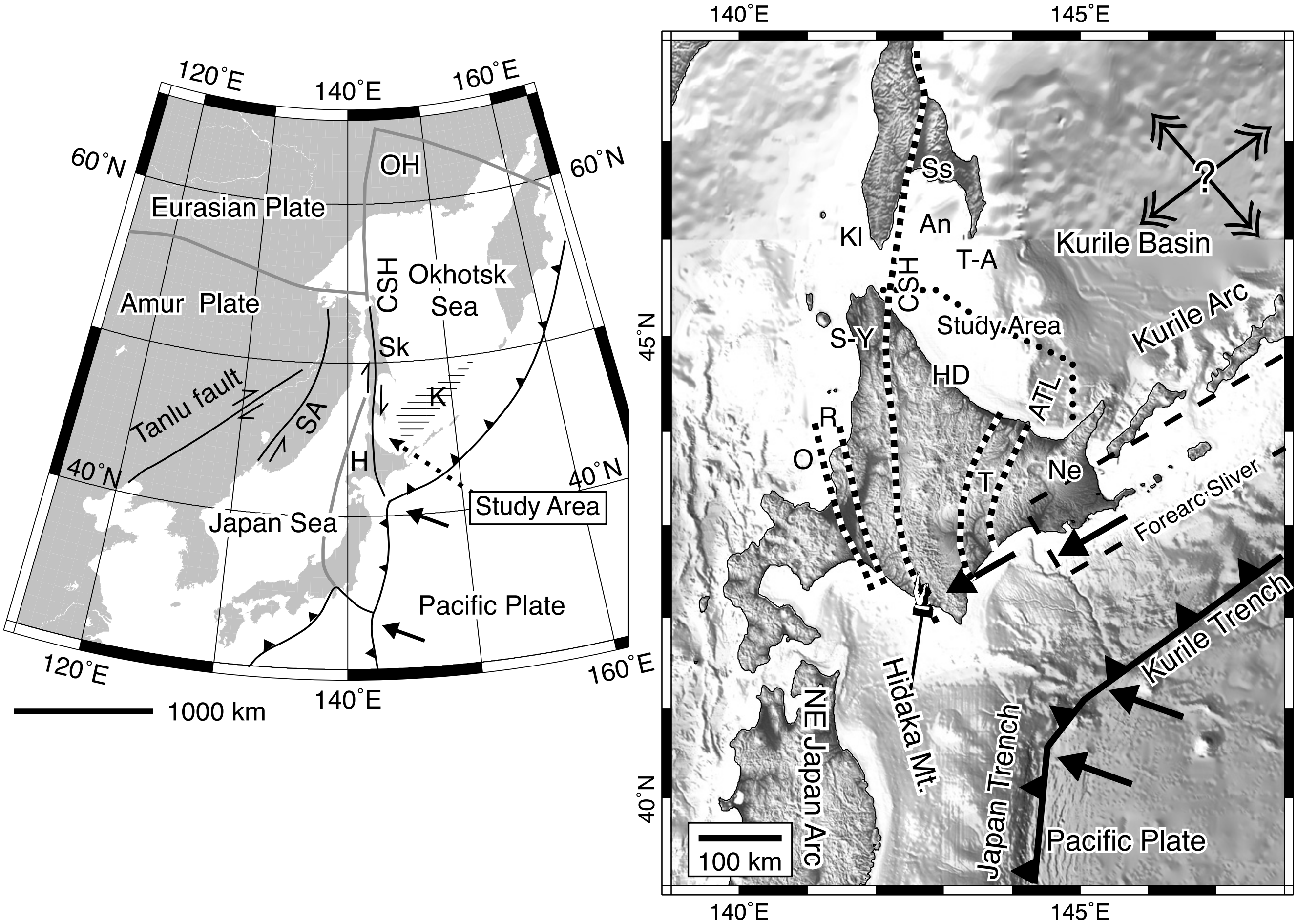

Fig. 1. Index maps of the Kurile and NE Japan arcs, NW Pacific (left) and Sakhalin–Hokkaido area (right). Plate boundaries are simplified from Jolivet (1987), Worrall et al. (1996), Seno et al. (1996), and Sella et al. (2002). An, Aniva Bay, ATL: Abasiri Tectonic Line, CSH: Central Sakhalin–Hokkaido Shear Zone, HD: Hidaka belt, Kl: Kril'on Peninsula, Ne: Nemuro belt, O: Osima belt, R: Rebun–Kabato belt, Sk: Sakhalin SA: Sikhote Al'in Fault, Ss: Susunai, S-Y: Sorachi–Yezo belt, T: Tokoro belt, and T–A: Toninio–Aniva Peninsula.

of compression or extension would be expected at block boundaries. These structural features, however, have not been verified, at least in the offshore areas of eastern Hokkaido, where we studied.

The dextral shear in Sakhalin and Hokkaido is related to the opening of two baskarc basins, i.e., the Japan and the Kurile basins (Fournier et al., 1994; Kimura and Tamaki, 1986; Jolivet et al., 1994). In contrast to the well-investigated Japan basin, the Kurile Basin requires further investigation and has two issues that must be addressed: the timing of the cessation of opening and the direction of the spreading axis.

On the basis of heat flow, siliciclastic stratigraphy, and plutonic magmatism, Kimura and Tamaki (1986), Niitsuma and Akiba (1986), Maeda (1990) and Gnibidenko et al. (1995) suggest that the opening of the Kurile Basin ceased as late as the Middle Miocene (ca. 15 Ma), Goto et al. (1995), Ikeda (1998) and Takeuchi et al. (1999), however, dated and characterised the various volcanics in Hokkaido and Sakhalin, and suggested that the opening of the Kurile Basin continued until the Late Miocene (9–7 Ma). This conclusion was questioned by Hirose and Nakagawa (1999) who suggested that the geochemistry of 14–9 Ma andesite–dacite in Central and Eastern Hokkaido is characterised by arc types, and concluded that the opening of the basin ceased approximately 14 Ma. However, basalt, high Ti-content icelandite, and Fe/Mg andesite occurred in northeastern Hokkaido, suggesting the opening of the backarc from 7 to 14 Ma (Goto et al., 1995; Ikeda et al., 2000) The chemistry of the volcanics varied from arc-type to backarc type. The chemistry of magmatic rocks depends on PT conditions and other petrogenic parameters of a site where melting occurs, and does not directly indicate a state of stress. The stress field can be determined by examining the basin structure.

The origin of the Kurile Basin has been attributed to backarc spreading with two possible variants in the direction of spread. In the first model, it is assumed that the spreading axis trends parallel to the Kurile Arc and that the opening occurred in the NW–SE trending direction (Kimura and Tamaki, 1986). According to the second model, the spreading axis presumably strikes NW–SE and the basin opening was caused by dextral shearing along a NE-trending zone located to the south of the Kuri-