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Description of a NW-trending brittle shear zone, Ulaanbaatar, Mongolia

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Abstract

A fault trending NW-SE from central Ulaanbaatar to Nalaikh, Mongolia, has been inferred from a topographical viewpoint, however, its lithological and kinematical characteristics remain uncertain. This paper describes the lithology and kinematics of this fault. The rocks of the Gorkhi Formation are intensely fractured to form a brittle shear zone sub-parallel to the topographical lineament from central Ulaanbaatar to Nalaikh. The fractured rocks are partly foliated with vertical planes striking N 15˚ to 30˚W. The shear zone extends for ca. 40 km north from Nalaikh. Dragging fold and P–Y fabric of the fractured rocks show top-to-the south sense of shear.

Introduction

Although many studies on Paleozoic basement rocks in and around Ulaanbaatar, Mongolia, have been carried out to discuss the tectonic development of the Central Asian Orogenic belt (e.g., Kashiwagi et al., 2004; Minjin et al., 2006; Kurihara et al., 2009), stratigraphy and geological structure of this area have far only been published in a geological map sheet (Magic Project, 1998). In addition, a fault trending NW-SE from central Ulaanbaatar to Nalaikh has been inferred from a topographical viewpoint, however, its lithology and kinematics remain uncertain and it has never been drawn in the previous geological map (e.g. Magic Project, 1998). A geological mapping project between Mongolian University of Science and Technology and Nagoya University, Japan, has been carried out to reveal the detail stratigraphy and structure of the Gorkhi, Altan-Ovoo and Orgioch Formations in the Ulaanbaatar area since 2009, and a brittle shear zone sub-parallel to the topographical lineament, which might be related to the topographically-inferred fault, was discovered in the course of this project (Figs. 1, 2 and 3). The lithology and kinematics of the shear zone are described in this paper.

Geological outline of the Ulaanbaatar area

Paleozoic sandstone and mudstone with minor amounts of felsic tuff, chert, basalts lime stone and conglomerate are exposed in this area (Takeuchi et al., 2013). The Paleozoic rocks of this area is divided into the Gorkhi, Altan-Ovoo and Orgioch Formations of the Devonian to Carboniferous (?) accretionary complexes (e.g. Minjin et al., 2006; Kurihara et al., 2009; Takeuchi et al., 2013). The Paleozoic rocks are intruded by Mesozoic Bogd-Khaan mountain granite.

In the area between the central Ulaanbaatar to Nalaikh, thick sandstone with minor chert lenses of the Gorkhi Formation are exposed (Nakane et al., 2013; Suzuki et al., 2013; Takeuchi et al., 2013). The rocks of this area are cut by NW-SE trending and NE-SW trending vertical faults to form fault-bound blocks (Takeuchi et al., 2013).

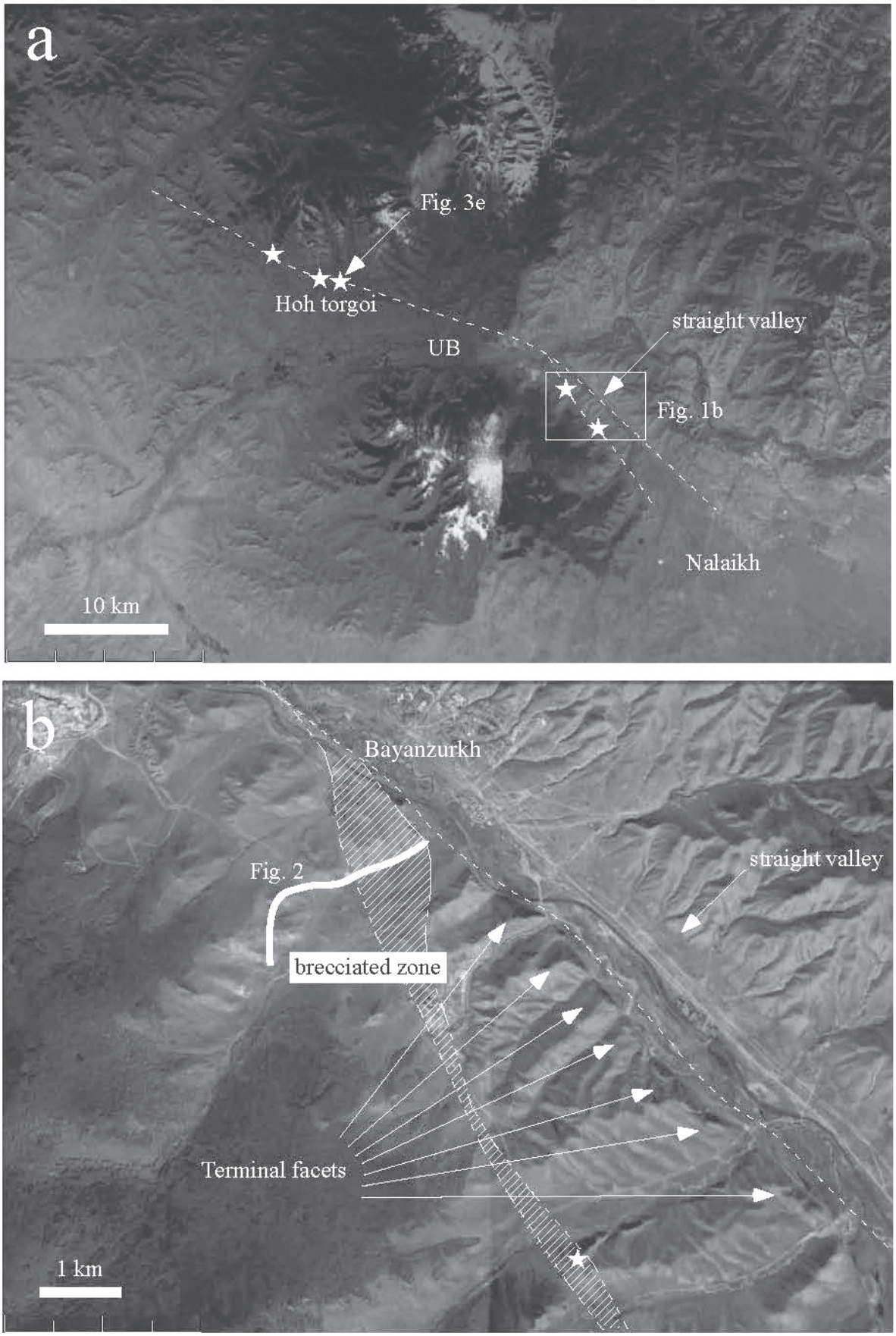

Fig. 1. Index map of the study area. The localities of the brecciated rocks are also shown with white stars. Dotted lines denote NW-trending fault. The topographic images were from Google (2012). UB: central Ulaanbaatar.

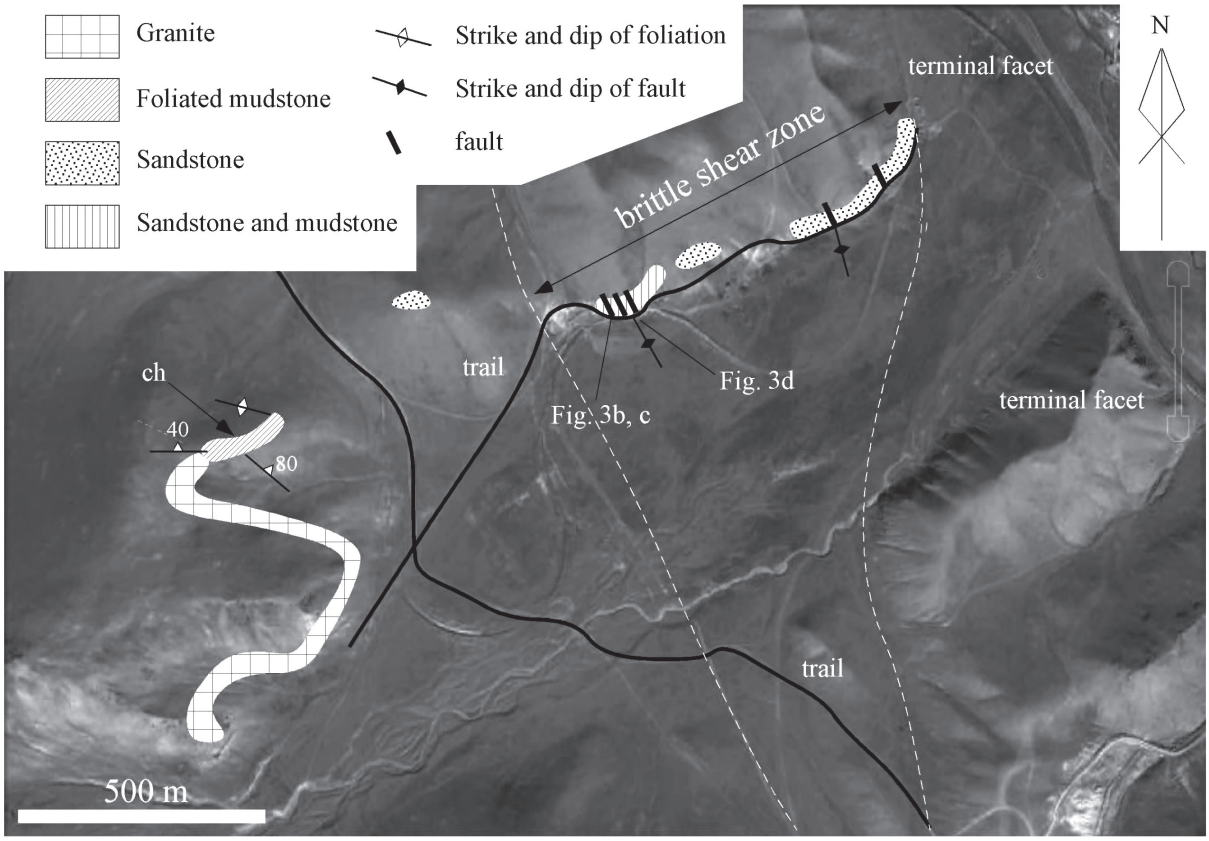

Fig. 2. Route map along the trail at Bayanzurkh.

Description of the brittle shear zone

A dissected straight valley of ca. 1 km wide is developed along the road from central Ulaanbaatar to Nalaikh to form topographical lineament and clear terminal facets (Figs. 1 and 3a). The tops of the facets are several tens meters high from the bottom of the valley. The foliated / non-foliated clastic rocks with a chert intercalation of the Gorkhi Formation are intensely fractured to form a brittle shear zone sub-parallel to this lineament (Figs. 1 and 3a). The fractured rocks, i.e. fault gouge and brecciated rocks, are well-exposed along the trail at Bayanzurkh (Figs. 2 and 3). Sandstone and mudstone of the Gorkhi Formation are brecciated and crushed for ca. 700 m wide (Figs. 2 and 3). The fractured rocks are unconsolidated. Open cracks are generally developed in the rocks, and some rocks include many clasts of 2 to 5 cm diameter in a finer matrix with random fabric to form fault gouge (Figs. 3b and c). The gouge is foliated with a spacing of several mm to 10 cm in some places and the foliation strikes N 15˚ to 30˚ W and vertical. Some minor vertical faults, 1 to 5 m wide, striking N 15˚ to 30˚ W are exposed along the trail (Figs. 2 and 3d). The shear zone extends at least for ca. 40 km north from Nalaikh (Fig. 1). Intensely fractured rocks of the chert and sandstone with foliation striking N 65˚ to 80˚ W and dipping 50˚ N to 90˚ are exposed at ca. 20 km northwest of the trail (Fig. 1). The planes are folded and show composite planer structures. The dragging fold and P–Y fabric of the fractured rock show top-to-the south sense of shear (Figs. 1 and 3e). A fault gouge including many well-rounded red chert clasts in a finer siliseous matrix around the Hoh torgoi is estimated to be a northern extension of this shear zone (Fig. 1).

Summary

1. The rocks of the Gorkhi Formation are intensely fractured to form a brittle shear zone sub-parallel to the topographical lineament from central Ulaanbaatar to Nalaikh.
2. The shear zone extends at least for ca. 40 km north from Nalaikh.

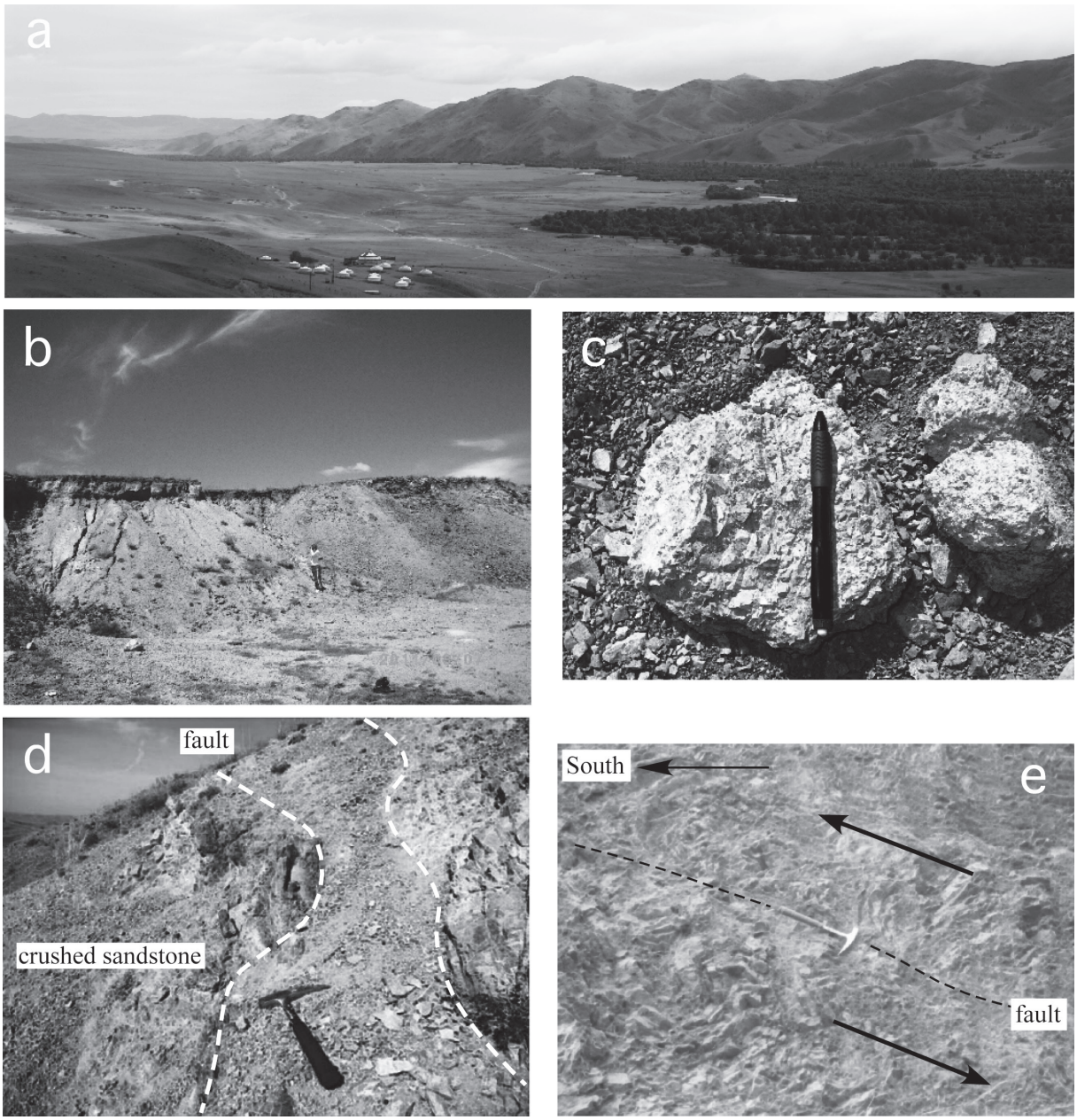

Fig. 3. Photographs showing field evidence of the brecciated rocks. a: Terminal facets along the road from central Ulaanbaatar to Nalaikh. b and c: The fractured rocks at the brittle shear zone sub-parallel to the lineament. d: A minor vertical fault along the trail. e: Dragging fold showing the top-to-the south sense of shear along a minor fault at the Hoh torgoi. Perpendicular view.

3. A part of the fractured rocks are foliated with a spacing of several mm to 10 cm in some places and the foliation strikes N 15 ˚ to 30˚ W and vertical.
4. Dragging fold and P–Y fabric of the fractured rocks show top-to-the south sense of shear.

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References

Kashiwagi, K., Tsukada, K. and Minjin, C. (2004) Paleozoic spherical radiolarians from the Gorkhi Formation, southwest Khentei range, central Mongolia, a preliminary report. *Mongolian Geoscientist*, **24**, 17-26.

Kurihara, K., Tsukada, K., Otoh, S., Kashiwagi, K., Minjin, C., Dorjsuren, B., Bujinlkham, B., Sersmaa, G., Manchuk, N., Niwa, M., Tokiwa, T., Hikichi, G. and Kozuka, T. (2009) Upper Silurian and Devonian pelagic deep water radiolarian chert from the Khangai Khentei belt of Central Mongolia: evidence for Middle Paleozoic subduction accretion activity in the Central Asian Orogenic Belt. *Journal of Asian Earth Sciences*, **34**, 209 225.

Minjin, C., Tumurtogoo, O. and Dorjsuren, B. (2006) Devonian Carboniferous accretionary complex of the Ulaanbaatar terrane, *In* Tomurhuu, D., Natal'in, B. A., Ariunchimeg, Ya., Khishigsuren, S. & Erdenesaikhan, G. (eds.) (2006) *Structural and tectonic correlation across the Central Asia Orogenic Collage: Implications for continental growth and intracontinental deformation (Second international workshop and field excursions for IGC Project 480), abstract and excursion guidebook*, 100-106, IGCP 480, Ulaanbaatar.

Magic Project (1998) *Geologic map of Ulaanbaatar, scale 1:100,000*. Geological Information Center, Ulaanbaatar.

Nakane Y., Bakhat, N., Suzuki, T., Jamiya, Manchuk, N., Takeuchi, M., Tsukada, K., Sersmaa G. and Khishigsuren S. (2013) Geological division of the rocks at southeast of Ulaanbaatar (Gachuurt-Nalaikh), central Mongolia. *Bulletin of the Nagoya University Museum*, No.28, 19-26.

Suzuki T., Nakane, Y., Bakhat, N., Takeuchi, M., Tsukada, K., Sersmaa G. and Khishigsuren S. (2013) Description of sandstones in the Ulaanbaatar area, Mongolia. *Bulletin of the Nagoya University Museum*, No.28, 27-38.

Takeuchi, M., Tsukada, K., Suzuki, T., Nakane, Y., Sersmaa, G., Manchuk, N., Kondo, T., Matsuzawa, N., Bakhat, N., Khishigsuren, S., Onon, G., Katsurada, Y., Hashimoto, M., Kawahara, K., Yamasaki, S., Matsumoto, A., Oyu-Erdene, B., Bulgantsengel, M., Kundyz, S., Enkhchimeg, L., Ganzorig, R., Myagmarsuren, G., Jamiyandagva, O. and Molomjamts, M. (2013) Stratigraphy and geological structure of the Paleozoic system around Ulaanbaatar, Mongolia. *Bulletin of the Nagoya University Museum*, No.28, 1-18.

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