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メタデータ	言語: eng 出版者: 公開日: 2008-01-31 キーワード (Ja): キーワード (En): 作成者: Wada, Hideki, Kehelpannala, K. V. Wilbert, Hamana, Noriaki, Ranaweera, Lalindra メールアドレス: 所属:
URL	https://doi.org/10.14945/00000543

静岡大学地球科学研究報告 33（2006年7月）9頁～19頁
Geosci. Repts. Shizuoka Univ., 33 (July, 2006), 9-19

Cataclastic rocks from the granulite terrain of Sri Lanka: evidence for younger brittle deformation of the exhumed lower crust

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Abstract Precambrian lower crustal rocks of Sri Lanka have undergone brittle faulting and fracturing. Here we studied the structures and fault rocks associated with the Randenigala fault, one of the major faults found in the basement of Sri Lanka. Field studies, petrography, SEM analysis and X-ray power diffraction of the cataclastic rocks associated with the fault indicate that the rocks have been formed at shallow depth, probably within 1-4 km of the crust, suggesting that the related brittle deformation is a younger event. We relate this brittle deformation to the tectonics in the Indian Ocean. Brittle faults in the basement have probably been formed at various stages since the break-up of Gondwana around Sri Lanka at about 130 Ma. Reactivation of early faults and formation of new ones could have occurred during subsequent events. The motion across the Indian Ocean related to the boundary between the Indian and Australian plates may have a significant effect on brittle tectonics in Sri Lanka. Apart from reactivation of existing faults, some faults could have been originated in the basement by the tectonics related to this motion, especially at 7.5-8 Ma. We speculate that the E-W trending Randenigala fault and other similar faults in Sri Lanka may be related to the onset of the E-W faulting and folding, which occurred at 7.5-8 Ma, in the central Indian Ocean. It is suggested that the current nearly N-S compression in the Indo-Sri Lankan lithosphere is responsible for recurrent seismicity and crustal movements in and around Sri Lanka.

Key words: Sri Lanka, Indian Ocean, brittle faulting, cataclastic rocks, intracontinental deformation

Introduction

The island of Sri Lanka, situated in the north-central Indian Ocean (Fig. 1), exposes a section of the lower crust of the Earth. Rocks of the basement of the Island have undergone strong ductile deformation and high-grade metamorphism at deeper crustal levels, mainly during the Pan-African assembly of Gondwana (*e.g.* Kröner *et al.*, 2003; Kehelpannala, 2004). Although its basement geology, granulite metamorphism and ductile deformations have been studied in more detail, little attention has been paid to study its brittle deformation (*e.g.* Kehelpannala, 1983, 1987, 2003; Vitanage, 1985). Generally, high-grade metamorphic terrains are devoid of brittle faults and fractures unless they have undergone brittle deformation after their exhumation to the upper crustal levels. Although intense deformation is usually taking place in association with plate margins, intraplate or intralithospheric deformations are not rare. Such an example is the equatorial Indian plate, where it is currently undergoing internal deformation (Chamot-Rooke *et al.*, 1993; Van Orman *et al.*, 1995; Royer & Gordon, 1997; Gordon *et al.*, 1998; Krishna *et al.*, 2001) leading to moderate-major earthquakes. Sri Lanka is situated just north of this deformation zone (Fig. 1), and the island seams to have been affected by the onset of the deformation (*e.g.* Kehelpannala, 2005). The effect of the onset of the internal deformation, which probably begun slowly at about 18 Ma and accelerated at about 8 Ma (Gordon *et al.*, 1998), of the Indian lithosphere may be manifested in Sri Lanka by fracturing and faulting and/or reactivation of pre-existing faults (e.g. Kehelpannala, 2005).

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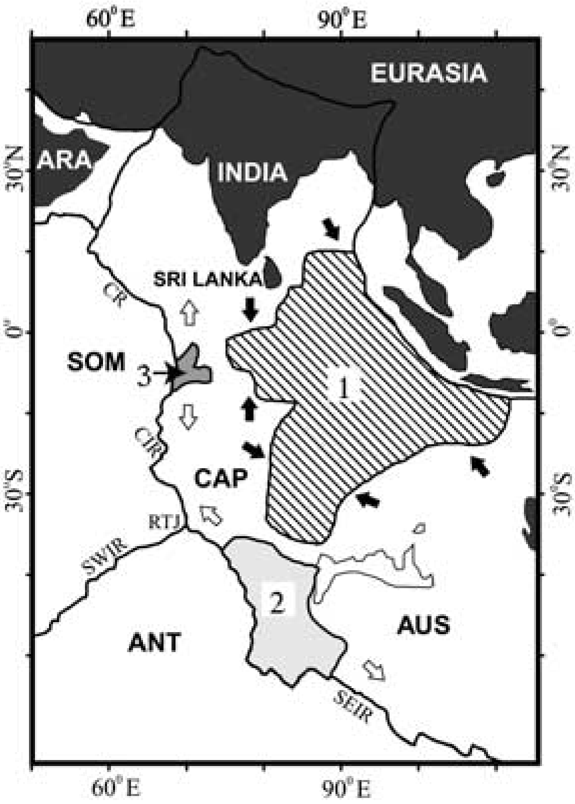

Fig. 1 Geometry of the plates in the Indian Ocean after Royer and Gordon (1997). ANT - Antarctic plate, ARA - Arabian plate, AUS - Australian plate, CAP - Capricorn plate, EUR-ASIA - Eurasian plate, INDIA - Indian plate, SOM - Somalian plate, CR - Carlsberg Ridge, CIR - Central Indian Ridge, SEIR - Southeast Indian Ridge, SWIR - Southwest Indian Ridge, RTJ - Rodrigues triple junction, 1 - diffused convergent boundary between the Indian and Australian plates, 2 - diffused divergent boundary between the Australian and Capricorn plates, 3 - diffused divergent boundary between the Indian and Capricorn plates.

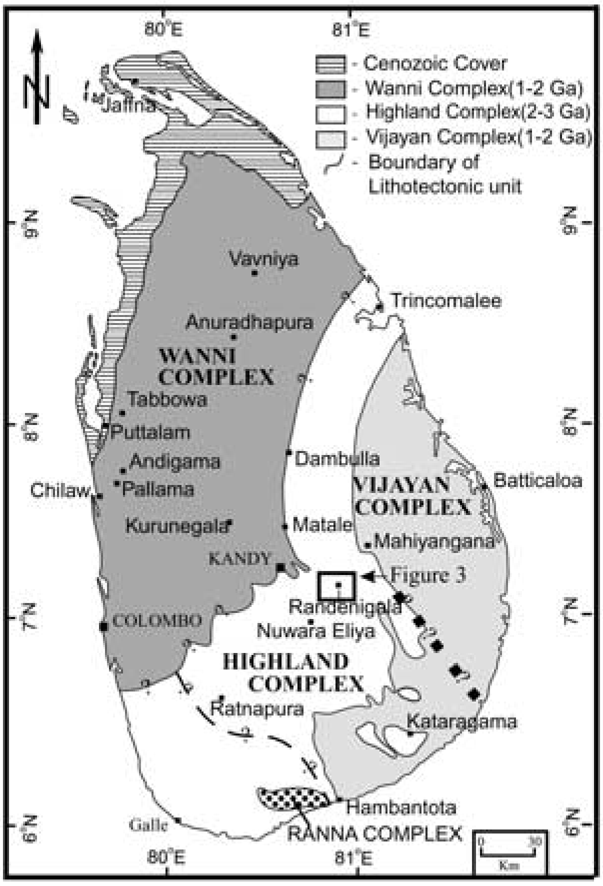

Fig. 2 Map showing the crustal blocks in Sri Lanka and study area. Crustal boundaries after Kehelpannala (2004).

Although a large number of brittle faults and fractures have been recognized in the basement of Sri Lanka, very little is known about their origin (Kehelpannala, 1983, 1987, 2003, 2006a; Vitanage, 1985). Along some of these faults, cataclastic rocks have been reported (Kehelpannala, 1987, 2003), and their nature and origin have not yet been fully understood. It is important to note that recurrent movements along these faults could be the causes for the seismic activity in the Precambrian basement of the country (*e.g.* Fernando & Kulasinghe, 1986; Kehelpannala, 1987, 2003, 2006b; Vitanage, 1995). A detailed study of these brittle faults and associated cataclastic rocks is fundamentally important for understanding mechanisms of brittle deformation of lower crustal rocks in general and neotectonics and the associated seismic activity in the Precambrian shield terrain of Sri Lanka, in particular. In order to understand some of these important problems and to study brittle deformation of lower crustal rocks, the first author undertook a research project on "Neotectonics, brittle deformation and seismicity" in the Precambrian basement funded by the National Science Foundation of Sri Lanka. In this paper we report, for the first time from Sri Lanka, results of a study of cataclastic rocks discovered along one of such large brittle faults and discuss the brittle deformation of lower crustal rocks exposed in the Sri Lankan basement.

Geology of Sri Lanka

About 90 percent of the Proterozoic basement of Sri Lanka is made up of high-grade metamorphic rocks, and the rest being covered by Cenozoic sediments and intruded by minor Cambrian granites, pegmatites and syenites. In addition, sedimentary rocks of Lower Cretaceous-Upper Jurassic age occur in small basins formed by faulting of the basement at Tabbowa, Andigama and Pallama in the northwestern part of the country (Fig. 2). The Proterozoic high-grade basement of Sri Lanka consists of three major crustal blocks (Fig. 2), namely (i) the Wanni Complex (WC), (ii) the Highland Complex (HC), and (iii) the Vijayan Complex (VC), brought into contact by two separate collisions during the Pan-African assembly of Gondwana (*e.g.* Kehelpannala, 1997, 2003, 2004), when East- and West-Gondwana collided (*e.g.* Kröner, 1991). Major rock types in the basement are quartzite, marble, calc-silicate gneiss, metapelite, metasemipelite, metagranitoid, charnockite and charnockitic gneiss, metagabbro, metadiorite, amphibolite, metabasite, migmatite, metamonzodiorite and post-tectonic granitoid and pegmatite.

With the exception of Cambrian post-tectonic granitoid and pegmatite, all the supracrustal and metaigneous rocks of these crustal blocks were intensely deformed by several phases of ductile deformations and were metamorphosed at about 610-550 Ma (Kröner & Williams, 1993; Kehelpannala, 1997) at middle to deep crustal levels, probably as the consequence of the above two collisions (Kehelpannala, 2003, 2004).

Method of study

A reconnaissance study of topographic lineaments from satellite images, provided by Google Earth (http://earth.google.com), covering the central Sri Lanka (Fig. 2, Plate 1-A) were carried out by the principal author. During this preliminary study, a large number of lineaments were recognized and traced from the satellite images. It was observed that a major E-W trending lineament runs through the Randenigala dam (Plate 1-A), one of the major hydropower dams in Sri Lanka. Because of this reason, the above lineament was selected for a detailed study. During the field study, several brittle faults, fractures and cataclastic rocks related to the lineament were discovered. Thus, the lineament is named here as the Randenigala fault. Orientation data were collected from the faults and fractures, and the thickest cataclastic rocks so far identified was collected for a detailed study. Petrofabrics of the cataclastic rocks were studied at the Institute of Fundamental Studies, and electron microscopic and XRD analyses of the rocks were carried out at the Shizuoka University, Japan. The fine matrix of the cataclastic rock was carefully separated and powered for X-ray power diffraction. The fault gouge material, which makes a very fine layer, covering the slickenside surfaces of fault planes was also separated and studied for X-ray powder diffraction. Three samples from the former and one sample from the latter were analyzed using the X-ray diffractometer (RINT 2000, Rigaku Co. Ltd.) at the Centre for Instrumental Analysis, Shizuoka University. The microscopic fabrics of the cataclastic rock were studied by using the JEOL (JSM-5600LV) Scanning Electron Microscope at the Institute of Geosciences of the same university.

Brittle structures

Preliminary studies by previous workers (*e.g.* Vitanage, 1959, 1985; Kehelpannala, 1983, 1987, 2003, 2006a) indicate that all three Precambrian crustal units in Sri Lanka have undergone brittle deformations, probably related to the tectonics during and after the opening of the Indian Ocean (Kehelpannala, 1987, 2003). The Sri Lankan high-grade basement has been criss-crossed by several sets of brittle faults and fractures, oriented in the directions of NNW-SSE, NNE-SSW, NW-SE, NE-SW, WNW-SES, ENE-WSW and E-W (Kehelpannala, 1983, 1987, 2003). These brittle fractures, the length of which ranges from less than 1 km to over 100 km, partly control the present day morphology of the island (Kehelpannala, 1987, 2003). They are characterized by linear zones of sub-parallel and vertical to sub-vertical brittle fractures (Kehelpannala, 2003). Horizontal slickenside striations on fracture and fault planes suggest that most of the brittle faults in Sri Lanka are strike-slip faults. Some of these strike-slip faults have subsequently been compressed to give rise to oblique-slip displacements shown by oblique slickenside striations (Kehelpannala, 1987, 2003).

Randenigala fault

Wall rocks and their ductile deformation

The Randenigala fault is a zone of nearly vertical, sub-parallel brittle fractures with an E-W orientation. The fault zone extends for over 35 km from near Galaha, SE of Kandy towards East of Rantembe through Kimbulantota and Randenigala (Fig. 2, Plate 1-A). Although the fault is not clearly visible in the satellite imagery studied, the analyses of air photographs and topographic maps and field studies confirmed its existence. The 94 m high, 485 m wide Randenigala rock-fill dam is built across this fault zone (Plate 1-A). The fault cuts the central part of the Highland Complex and displaces a sequence of granulites consisting of quartzite, marble, metapelite, charnockite, metagranite, metagabbro and metadiorite. These rocks have been strongly deformed and metamorphosed under granulite facies conditions. Some of the metapelitic granulites in the Highland Complex show ultra high temperature (UHT) assemblages (*e.g.* Sajeev & Osanai, 2004a, b; Osanai *et al.*, 2006), indicating that they were metamorphosed at the lowermost part of the crust.

However, the wall rocks of the fault near the Randenigala dam, where the present study was carried out and the studied cataclastic rocks were discovered, are two pyroxene metadiorite, two pyroxene metagabbro and charnockite, which are interlayered (Plate 1-B, Fig. 3). These are the major rock types found near the dam and are highly fractured by the fault. Both the metagabbro and metadiorite contain plagioclase, clinopyroxene, garnet, orthopyroxene and hornblende, and biotite is not always present in these rocks. However, some layers do not contain garnet. Apatite occurs as a minor phase in these rocks. The major mineral constituents of the charnockite and other charnockitic rocks are quartz, K-feldspar, plagioclase, garnet and orthopyroxene, and biotite may or may not be present. All these lithologies are medium- to coarse-grained and show typical granoblastic texture (Fig. 4) common to granulites. These rocks were intruded by quartzo-feldspathic granitic layers and mafic dikes. Strong non-coaxial deformation during the Pan-African orogeny has resulted in a parallel foliation (banded structure) comprising white, intermediate and dark layers (Kehelpannala, 1991, 1997, 2003).

Fig. 3 Nearly vertical fractures and faults associated with the Randenigala fault as exposed in a metadiorite quarry in the northern wall of the fault, N of the left abutment of the Randenigala dam. White arrows show faults with cataclastic rocks. The quarry face is more than 15 m high.

Fig. 4 Photomicrograph showing granulite texture of the two pyroxene granulite wall rock of the Randenigala fault near the Randenigala dam. Long edge of the photograph is 5.2 mm.

At least four major ductile deformations that are related to the Pan-African assembly of Gondwana (*e.g.* Voll & Keinschrodt, 1991; Kehelpannala, 1997, 2003, 2004) were recognized in the wall rock granulites. P-T conditions prevailed during these deformations clearly indicate that all the ductile structures were developed at deep crustal levels (*e.g.* Voll & Kleinschrodt, 1991; Kleinschrodt & Voll, 1994; Kehelpannala, 1997). The earliest deformation recognized in these rocks is shown by intensely developed foliation (banding) and stretching lineation (D_2 of Kehelpannala, 1997), and the observed isoclinal folds (D_3 of Kehelpannala, 1997) are related to the next deformation. The foliation near the Randenigala dam is nearly N-S (N 2-7° W) and dips to the east with a steep angle (70°-88°) (Plate 1). The stretching lineation is almost horizontal (plunge angle of 2°-5°) and strikes in a NNW-SSE direction.

All the rock layers in the study area have been folded into a regional-scale asymmetric synform, which represents the next strongest ductile phase of deformation (D_5 of Kehelpannala, 1997). The axis of the synform is nearly horizontal and strikes in a NNW-SSE direction. The western limb of the synform is sub-vertical and is located in the study area near the Randenigala dam (Plate 1-A). A flat foliation represented by flattened quartz in the charnockite and quartzo-feldspathic granitic layers was recognized, which may represent the axial plane foliation (S_5 of Kehelpannala, 1997) of the above synform. The brittle fractures associated with the Randenigala fault cross-cut all these ductile structures.

Structures associated with the Randenigala fault

The Randenigala fault zone is composed of a large number of nearly vertical and sub-parallel brittle fractures, the length of which ranges from a few metres to several tens of metres (Plate 1-B, Fig. 3). These secondary fractures are distributed in a very wide zone that is over 600 m across near the Randenigala dam. The width of the Randenigala fault zone is defined by the area over which the secondary fractures are distributed perpendicular to the fault zone. Most of the fractures are arranged in an en-echelon pattern along the entire length of the main fault zone. However, it was difficult to deduce their sense of stepping (left-stepping or right-stepping) since a major part of the fault zone is covered by the Randenigala reservoir. Two major sets of faults and fractures were observed in association with the main fault. The set that is parallel to the main fault zone is nearly E-W and dips steeply towards N or S. The other set that is nearly perpendicular to the main fault zone is nearly N-S and dips mainly towards W with a steep angle. It was observed that the intensity of fractures varies across the fault zone.

The salient feature of the Randenigala fault is the development of varying degrees of cataclastic rocks across the fault zone, as observed from its southern wall (Plate 1-B) to the northern wall (Fig. 3). Most of the associated fracture planes are smooth and slickensided (Fig. 5) and contain a thin (a few mm thick) layer of fault gouge. The slickenside striations observed in these planes are mostly horizontal (Fig. 5A), indicating that the apparent movement along the Randenigala fault was strike-slip. Some obliquely oriented striations (Fig. 5B) overprint the horizontal striations, indicating that the fault has a multiple movement history. However, a more detailed study on these slickenside striations is needed to determine the orientations of the palaeostress axes responsible for the faulting, thereby understanding the history of the movements of the Randenigala fault.

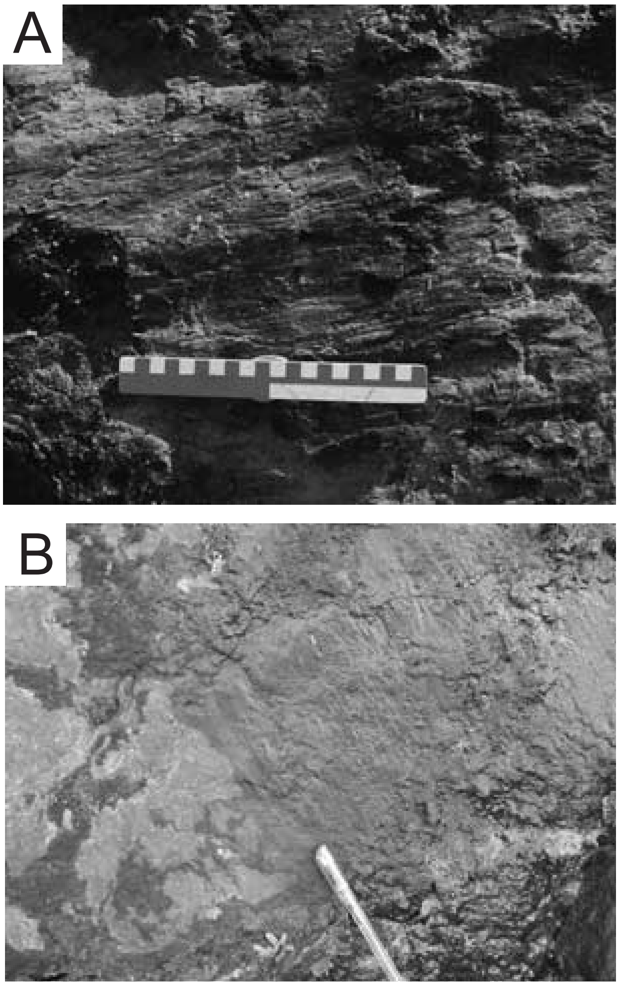

Fig. 5 Photographs showing slickenside striations associated with the Randenigala fault near the Randenigala dam. **A.** Nearly horizontal striations on a vertical fracture plane. **B.** Plunging striations on a vertical fracture plane.

Nature of the cataclastic rocks

During the field studies carried out along and across the Randenigala fault, zones of cataclastic rocks were discovered at many places (Plate 1-B, Fig. 3). These cataclastic rocks occur not only in the metagabbro and metadiorite but also in the charnockite near the Randenigala dam (Plate 1, Fig. 3). Although cataclastic rocks were discovered along the fault zone, we were unable to deduce the sense of displacement because of the large thickness (over 100-200 m) of the wall rocks in the study area. The thickness of the observed cataclastic zones varies from about 1 mm to about 30 cm. Here we studied the cataclastic rocks exposed at the road side (Plate 1-B) near the right abutment of the Randenigala dam.

The cataclastic rocks studied are exposed on a nearly vertical fault plane and are about 10-30 cm thick (Plate 1-B). The rocks are almost black in colour, and where it is weathered, the colour is changed to dark brown (Plate 1-B). The fault rocks show typical cataclastic texture with sharp, angular to sub-angular clasts and a fine matrix (Fig. 6). These cataclastic rocks are mostly incohesive, indicating that the faulting has taken place at very shallow depths, probably within 1 - 4 km of the crust (*e.g.* Twiss & Moores, 1992), indicating that the faulting is a younger event. Petrographic and scanning electron microscopic (SEM) images clearly demonstrate that this texture (Figs. 6, 7) is completely different and distinct from the granulite texture (Fig. 4) of the original wall rocks. The clasts consist of angular to sub-angular rock fragments of the wall rocks, quartz and feldspar, and a very few fragments of Fe-Mg minerals (Figs. 6, 7). The size of the clasts varies from some tens of centimetres (Plate 1-B) to about 10μm (Figs. 6, 7). However, the average size of the clasts ranges from some cm to about 30μm. Large clasts are generally wall rock fragments containing mostly quartz and feldspar grains, whereas small clasts are mainly quartz and feldspar. It was found that the Fe-Mg minerals in the wall rocks are more susceptible to alteration than quartz and feldspar, and major part of the matrix is made up of materials formed from the alteration of pyroxene, hornblende, garnet and biotite. Quartz is the most resistant mineral to alteration during the faulting, and feldspar is the next resistant one. However, of the two feldspars in the wall rocks, K-feldspar seams to be more resistant than plagioclase. The size of the clasts and the amount of the matrix (< 30%) suggest that the cataclastic rocks studied can be categorized under fault breccia (Twiss & Morres, 1992).

The matrix of the cataclastic rock is very fine-grained (Figs. 6, 7). Under the microscope, it is

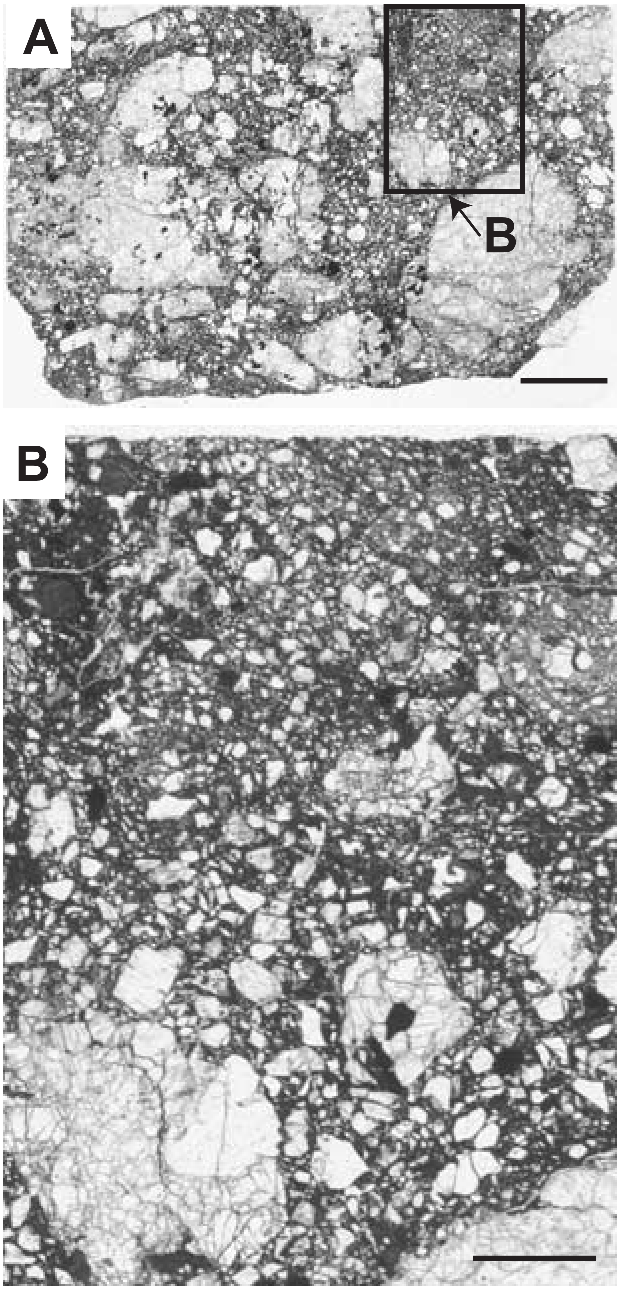

Fig. 6 Scanned images of a thin section showing the characteristic texture of the cataclastic rock (fault breccia) in Plate 1-B. An enlargement of the rectangle area marked in A is shown in B. Note sharp, angular to sub-angular clasts of rock and mineral fragments. Scale bar in A is approximately 4.4 mm and in B is approximately 1.3 mm.

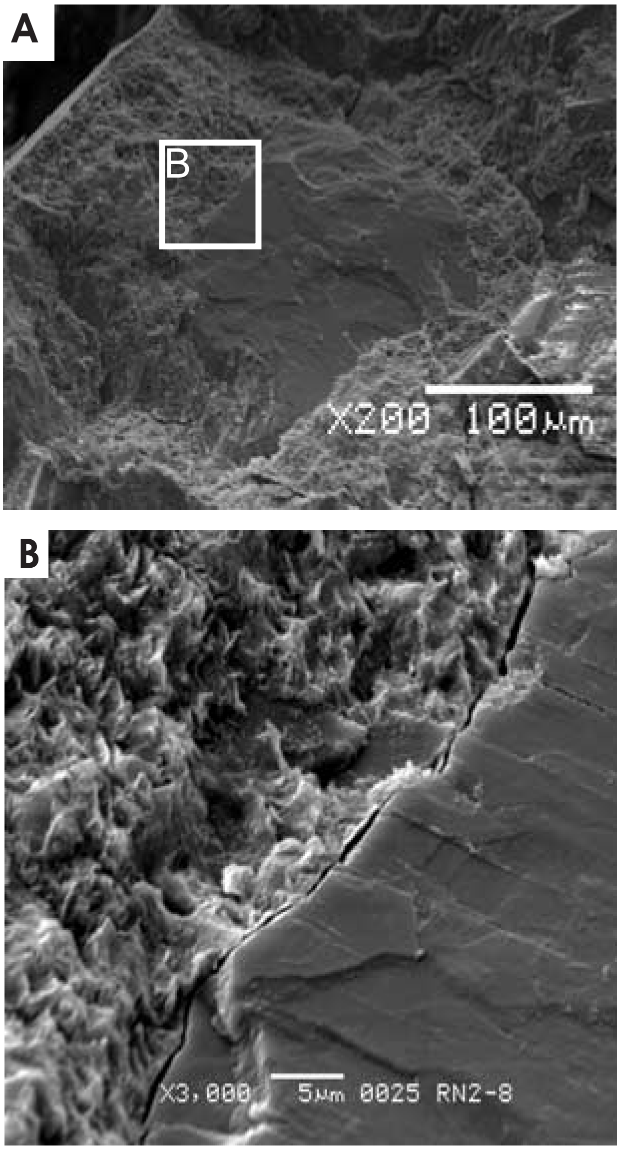

Fig. 7 SEM images showing the characteristic texture of the cataclastic rock in Plate 1-B and the sharp contact between clasts and the matrix (fine material). An enlargement of the rectangle area marked in A is shown in B. There is no preferred orientation in the rock. Note the open space between the feldspar clast (central grain in A) and the matrix in B.

mainly brownish green in colour and shows no or rare pleochroism. In addition to the brownish green colour materials, very fine quartz and feldspar clasts occur in the matrix. We carefully separated the matrix in three samples and finely powdered for X-ray powder diffraction. The XRD analyses of the samples show a main peak at 2θ values of 5.88°-5.82° (Fig. 8A-C) which corresponds to montmorillonite. The other major peaks in Figures 8A-C indicate the presence of very fine quartz and feldspar grains in the matrix (Figs. 6, 7). The X-ray diffractograms after glycolation of the powdered matrix samples by ethylene glycol show that the peak at 2θ values of 5.88°-5.82° was shifted to 2θ values of 5.46°-5.31° (Fig. 8A-C). This confirms the presence of montmorillonite in the matrix of all the samples of the cataclastic rocks studied. We also analysed one powder sample taken from the gouge material in one of the slickenside surfaces showing striations. The X-ray diffractograms of the sample, both before and after glycolation, show the presence of montmorillonite. The formation of montmorillonite in the cataclastic rocks associated with the Randenigala fault emphases that the rocks were formed

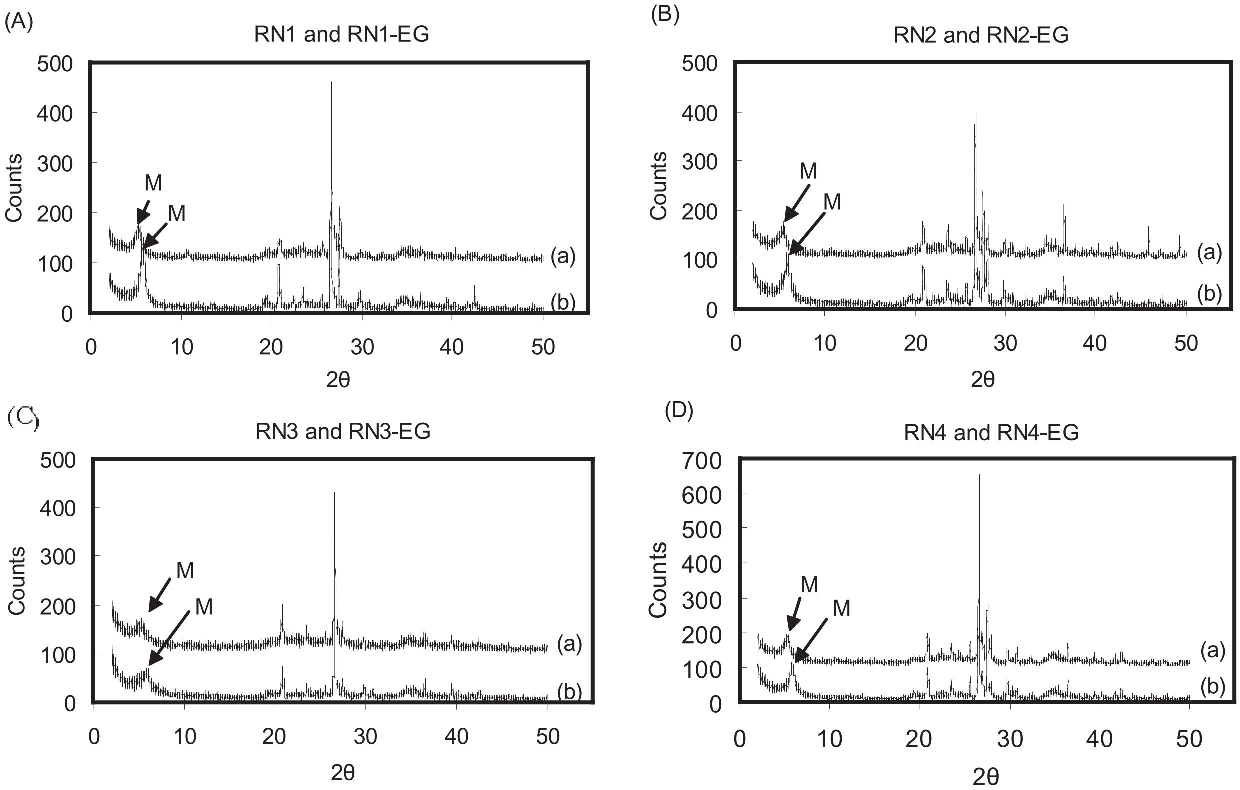

Fig. 8 X-ray diffractograms of the matrix of the cataclastic rock (A-C) in Plate 1-B and of the gouge material (D) collected from a fault plane of the Randenigala fault. (a) is the XRD diffractogram before glycolation by ethylene glycol and (b) is the diffractogram after glycolation. **M** shows the peak of montmorillonite. The other major peaks represent quartz and feldspar.

at very low temperatures, probably below 100℃, and that the fault was originated and active at shallow depths.

Discussion and conclusions

The presence of cataclastic rocks formed at shallow depths indicates that the Sri Lankan crust underwent younger brittle deformation. Although numerous brittle fractures cross-cutting the lower crustal rocks of Sri Lanka have been previously identified (*e.g.* Vitanage, 1959, 1972, 1985; Kehelpannala, 1983, 1987, 2003, 2006a), their origin is not properly constrained. These structures are characterized by linear zones of sub-parallel and vertical to sub-vertical brittle fractures (Kehelpannala, 1983, 1987, 2003) as mentioned earlier. One of the major problems in constraining the origin of these fractures is the lack of age data from the fault breccia identified in Sri Lanka (Kehelpannala, 1987, 2003, 2006a; this study). Kehelpannala (1983, 1987, 2003, 2006a) showed that the brittle fractures in the Precambrian basement of Sri Lanka have no genetic relationship to major ductile structures, such as foliations, shear zones and folds, which were formed during the Pan-African orogeny at about 610-550 Ma and suggested that they were formed during and/or after the break-up of Gondwana around Sri Lanka about 130 Ma ago, attributing their origin to the tectonics leading to the opening of the Indian Ocean (Kehelpannala, 2003, 2006a).

The equatorial Indian Ocean south of Sri Lanka (Fig. 1) has long been recognised as a site of active deformation, and its effect on the basement of Sri Lanka has yet to be fully understood. The presence of numerous E-W younger faults and folds recognized by deep seismic reflection profiling and deep sea drilling and of large earthquakes in the central Indian Ocean indicates that this part of the oceanic lithosphere is undergoing unusual deformation (*e.g.* Moore *et al.*, 1974; Weissel *et al.*, 1980; Cochran *et al.*, 1987; Curray & Munasinghe, 1989; Bull, 1990; Chamot-Rooke *et al.*, 1993; Van Orman *et al.*, 1995; Krishna *et al.*, 2001). This deformation, which began at 7.5-8 Ma, has been related to the diffused boundary between the Indian and Australian plates (Wiens *et al.*, 1985; Gordon *et al.*, 1990; Royer & Gordon, 1997; Van Orman *et al.*, 1995). However, Royer & Gordon (1997) have recently recognised three plates in the region SW, S and SE off Sri Lanka and named them as the Indian, Australian and Capricorn plates (Fig. 1). According to them, the boundary between the Indian and Australian plates south and southeast of Sri Lanka is undergoing horizontal convergence, whereas the western part of the margin between the Indian and Capricorn plates accommodates horizontal divergence (Fig. 1). The southern part of the Capricorn-Australian plate boundary accommodates horizontal divergence (Fig. 1). Although this deformation began at 7.5-8 Ma (*e.g.* Cochran *et al.*, 1987; Curray & Munasinghe, 1989; Van Orman *et al.*, 1995; Krishna *et al.*, 2001), plate reconstruction models show that the earliest interval of measurable motion between the Indian and Australian plates began more than 18 Ma ago (Gordon *et al.*, 1998).

The major deformation zone between the Indian and Australian plates lies about 350-500 km S and SE of Sri Lanka (Fig. 1), and we believe that its onset may have effected the basement of Sri Lanka causing either faulting or reactivation of some existing faults. Although we are unable to constrain unambiguously the timing of brittle faulting of Sri Lanka with the present data set, we believe that brittle deformation of the basement was related to the tectonics prevailed during and after the opening of the Indian Ocean as already suggested by Kehelpannala (1983, 1987, 2003, 2006a). Reactivation of some normal faults formed during the formation of the Indian Ocean by the compression related to the above deformation has also been observed (Chamot-Rooke *et al.*, 1993). Some faults may have been formed by the tectonics associated with the onset of the Indian-Australian plate boundary south of Sri Lanka (Fig. 1). The Randenigala fault runs in an E-W direction and is parallel to most of the faults in the Indian Ocean lithosphere, south of Sri Lanka. This parallelism leads us to speculate that the Randenigala fault and such similar faults in Sri Lanka are likely to be the result of the onset of the deformation in the central Indian Ocean (Fig. 1), which began at 7.5-8 Ma producing E-W faults and folds, related to the above plate boundary. However, dating of fault rocks will constrain the exact timing of the Randenigala fault as well as other faults in the lower crust of Sri Lanka.

This and previous studies suggest that the lower crust exposed in Sri Lanka has undergone brittle deformation, probably since the break-up of Gondwana, and that the lithosphere around Sri Lanka is undergoing deformation. The recurrent compression between the Himalayan collisional zone and the Indian-Australian convergent plate margin (Fig. 1) compresses the entire Indian plate around Sri Lanka in a nearly N-S direction, probably leading to bulging of the lithosphere, similar to the situation in northern India south of Himalaya (Bilham *et al.*, 2003). This inferred bulging, caused by the nearly N-S compression, seams to be the cause of younger deformation of the lithosphere in around Sri Lanka, including south India. Focal mechanisms of earthquakes occurred in the Indian Ocean, numerical modelling (*e.g.* Cloetingh & Wortel, 1986; Sandiford *et al.*, 2005) and GPS measurements (Catherine, 2004) show that the lithosphere around Sri Lanka and south India is currently undergoing nearly N-S compression, perhaps since the onset of the Indian/Australian plate boundary. This confirms the above inference and supports the suggestion of the existence of a nearly N-S compression by Kehelpannala (1983, 1987, 2003) based on faults mapped in Sri Lanka.

Reactivation of some extensional fractures, strike-slip faults and oblique-slip faults in Sri Lanka could have occurred due to this nearly N-S compression (Kehelpannala, 1983, 1987, 2003). Any increase in convergent rate at the boundary between the Indian and Australian plate may increase the N-S compression. It is possible that the Sri Lankan crust is still being compressed by the above N-S compression causing the faults with proper orientation to undergo high stresses, leading to activate these faults and causing seismic activities (Kehelpannala, 2003, 2006b). The presence of brittle faults, associated cataclastic rocks and the active N-S compression suggests that the basement of Sri Lanka is undergoing recurrent movements. Thus, this study stresses the need of continuous monitoring of (a) crustal movements in Sri Lanka using a network of GPS and (b) any increase in seismicity, especially for strengthening the safety of the major hydropower dams in the country.

Acknowledgements

Part of this study was funded by a grant (RG/2005/DMM/01) from the National Science Foundation of Sri Lanka to K.V.W. Kehelpannala (KVWK). The principal author (KVWK) wishes to thank the second author, Prof. Hideki Wada for inviting him to carry out research in Japan, supported by the JSPS project on "Study of the oxygen deficient syndrome beneath the super continents and the global carbon cycle and the role of graphite" (No. 15403016). The manuscript benefited from the constructive reviews of Prof. Kano Ken-ichi and Dr. Satish-Kumar. We thank Dr. Satish-Kumar for editorial handling. Thanks are also due to Dr. S. Yamada for his kind guidance for SEM observations.

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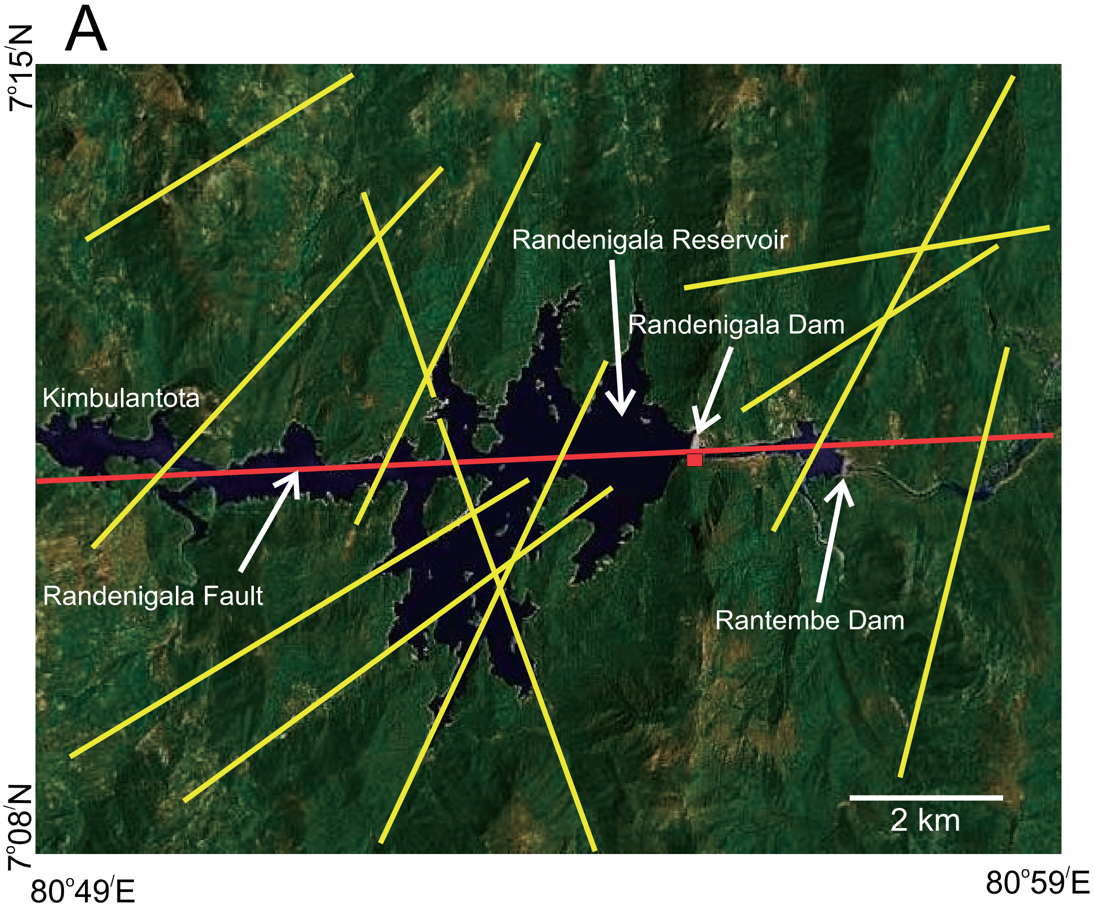

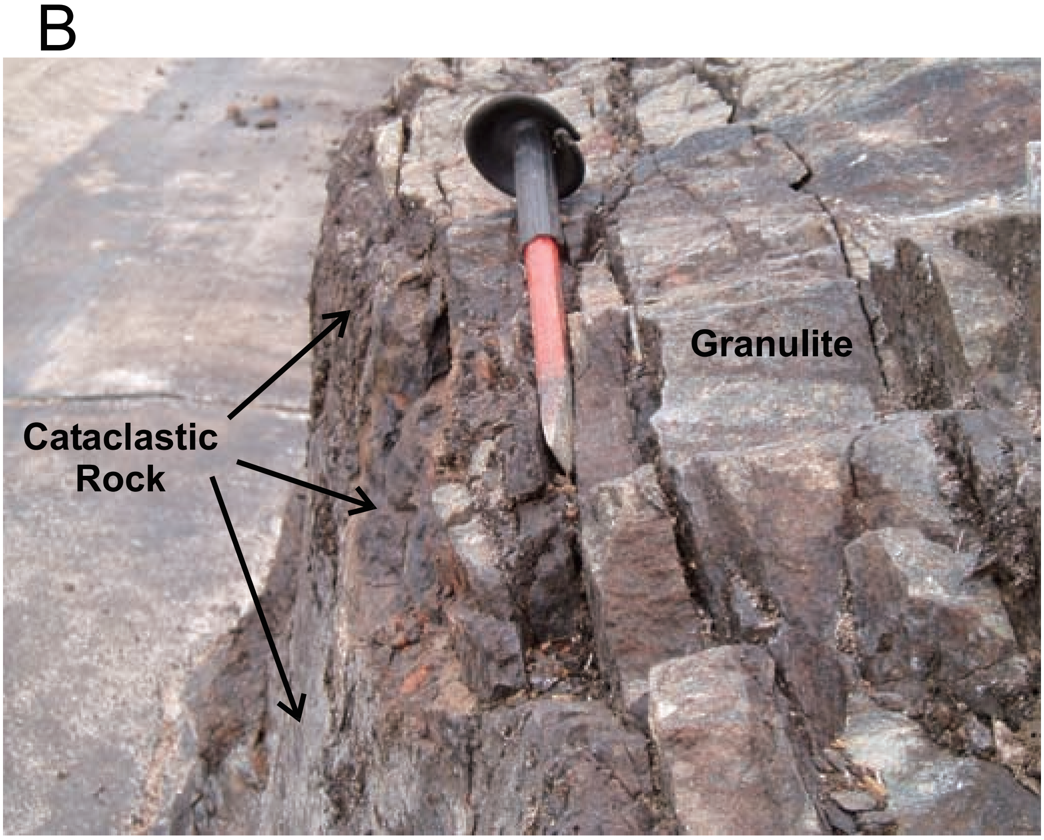

Plate 1

(A). Satellite image (down loaded from Google Earth) showing the Randenigala fault (E-W red line) and other major brittle fracture zones (yellow lines) in the area studied. Red square shows the sample location of the cataclastic rock in (B).

(B). Photograph showing the cataclastic rock (arrows) associated with the Randenigala fault near the right abutment of the Randenigala dam. The wall rock is charnockite with mafic bands and quartzo-feldspathic layers. The red square in Plate 1-A shows the location of the photograph.