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Sedimentary facies of the Tetori Group in the Shiramine, Ishikawa Prefecture

By

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with 1 Table and 10 Figures

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Abstract: The Mesozoic Tetori Group, exposed in the Shiramine area of Ishikawa Prefecture, is characterized by nonmarine deposits unconformably overlying the Hida Metamorphic Rocks. Sedimentological investigation of the upper part of the Akaiwa Formation (the upper part of the Tetori Group) recognized seven sedimentary facies (channel floor, sand bar, plane beds, crevasse splay, flood plain, vegetated swamp, and soil) and seven cycles; each of them generally appears fining upwards.

Stratigraphy of the upper part of the Akaiwa Formation shows a graded change from a gravely fluvial system (the lowest cycle) to a sandy meandering river system (the upper cycles). Nodular calcretes found from the soil facies indicate that the climate was once arid during sedimentation of the upper part of the Akaiwa Formation. However, it is inconsistent with well development of coal seams and carbonaceous mudstone.

Contents

I. Introduction

The Tetori Group is the middle Jurassic to early Cretaceous deposits in the Hokuriku province, central Japan. In recent years, many dinosaur bones and footprints have been found from the Tetori Group (Azuma, 1991; Azuma et al., 1992; The Gifu-ken Dinosaur Fossil Excavation Party, 1994). The Tetori Group in the Shiramine Village includes some of the localities (Azuma and Takeyama, 1991). Stratigraphy and geology of the Tetori Group in the Shiramine were previously discussed in many papers (Maeda, 1958; Maeda, 1961a; Kawai, 1961), but only few attempts have so far been made for sedimentological study.

The purposes of this paper are to describe sedimentary facies and to clarify sedimentary environments of the Tetori Group.

II. Geological setting

Study area is situated in the Shiramine Village, Ishikawa Prefecture (Fig. 1). Geology of the study area is divided into the Hida Metamorphic Rocks, and the Tetori Group. The Tetori Group rests unconformably on the Hida Metamorphic Rocks in a part of the area, while for most they are in a fault contact . The Tetori Group is generally divided into the Kuzuryu, Itoshiro, and Akaiwa Subgroups in an ascending order (Maeda, 1961b).

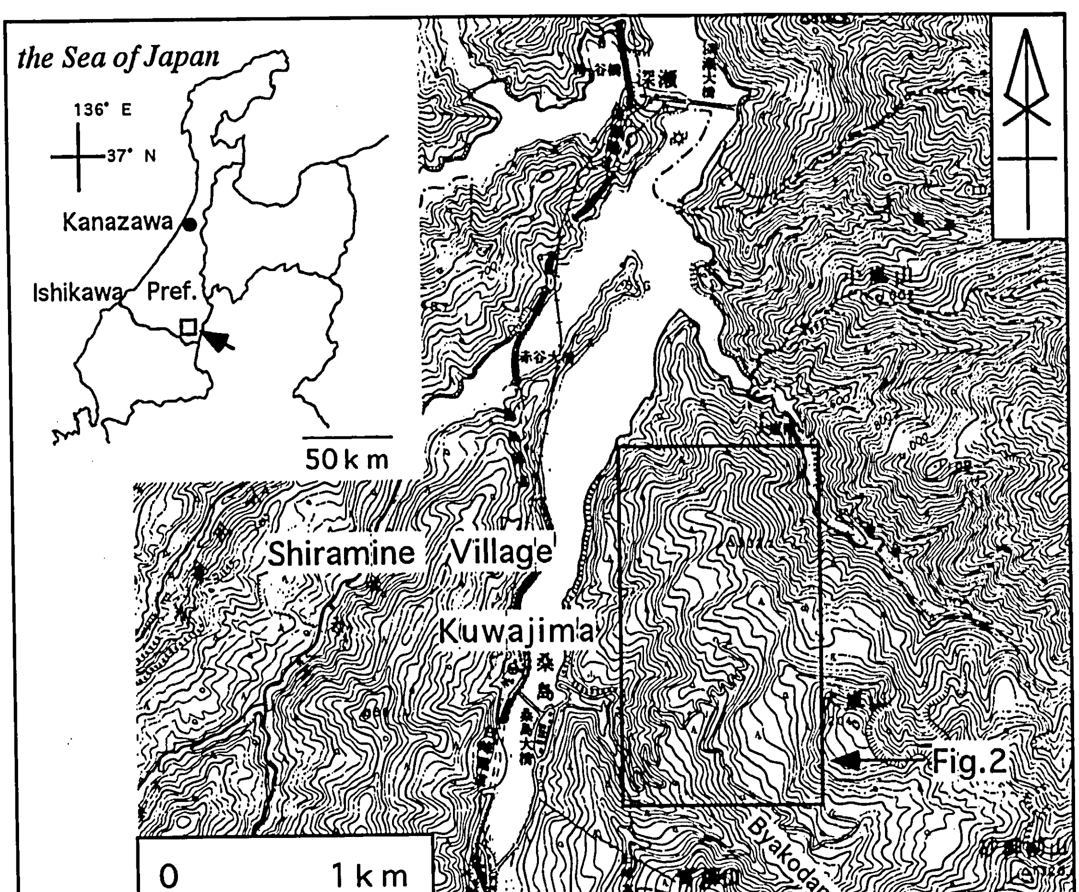

Fig. 1. Topographic map indicating the study area. The map is based on "Shiramine" 1:50,000 scale issued by Geographical Survey of Japan.

Among them, the Itoshiro and Akaiwa Subgroups are distributed in the Shiramine area. The Itoshiro Subgroup consists of the Kuwajima Formation (Oishi, 1933). The Akaiwa Subgroup is subdivided into Akaiwa Formation (Oishi, 1933) and Myodani Formation (Kawai, 1961) in an ascending order. Furthermore, the Akaiwa Formation is subdivided into lower part and upper part (Ishikawa Prefecture, 1978). Elect stumps (*Xenoxylon latiporosum*) were found from this formation (Maeda, 1958). The lower part of this formation mainly consists of an alternation of sandstone, mudstone, and conglomerate. Whereas, the upper part is mainly composed of sandstone.

This paper mainly focuses sedimentary facies and environments of the upper part of the Akaiwa Formation. A path of Byakodan almost continuously exposes the upper part of the Akaiwa Formation which shows a homoclinal structure striking NE-SE and dipping to south (Fig. 2).

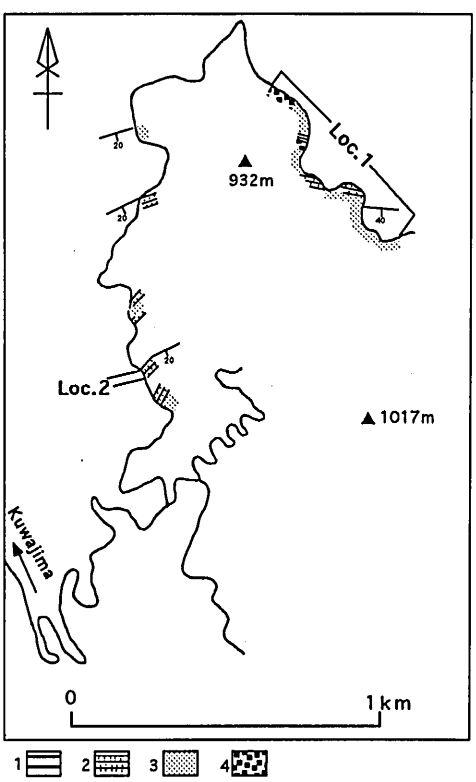

Fig. 2. Route map of the study area.
1: mudstone-siltstone, 2: alternating beds of sandstone and mudstone, 3: sandstone, 4: conglomerate

III. Sedimentary facies and environments

Localities 1 and 2, subjects of the facies analysis, are shown in Fig. 2. Seven sedimentary facies (Facies A-H) are obtained from the study section on the basis of the sedimentary facies analysis (Table 1). Columnar sections of the upper Akaiwa Formation in the study area are shown in Fig. 3 and Fig. 4. The seven facies are described in the followings.

Facies A: clast-supported conglomerate with crude horizontal stratification. This facies normally has an erosive base and shows imbrication of gravel (Fig. 5). A single bed of this facies ranges 1.5 to 4 meters in thickness.

This facies corresponds to lithofacies Gh (Miall, 1978), and is interpreted as a lag deposit in a channel. The erosional surface on the bottom is formed by channel cutting.

Facies B: trough and planar cross-bedded sandstone. The thickness of a set of the trough cross-bedding ranges from 10 to 40 centimeters. Grain size is generally medium to very coarse sand. Pebbles form trough cross-bedding.

This facies corresponds to lithofacies Gt and Gp (Miall, 1978) and is interpreted as a sand bar. Trough cross-bedding in the sandstone results from the formation of sinuous-crested dunes.

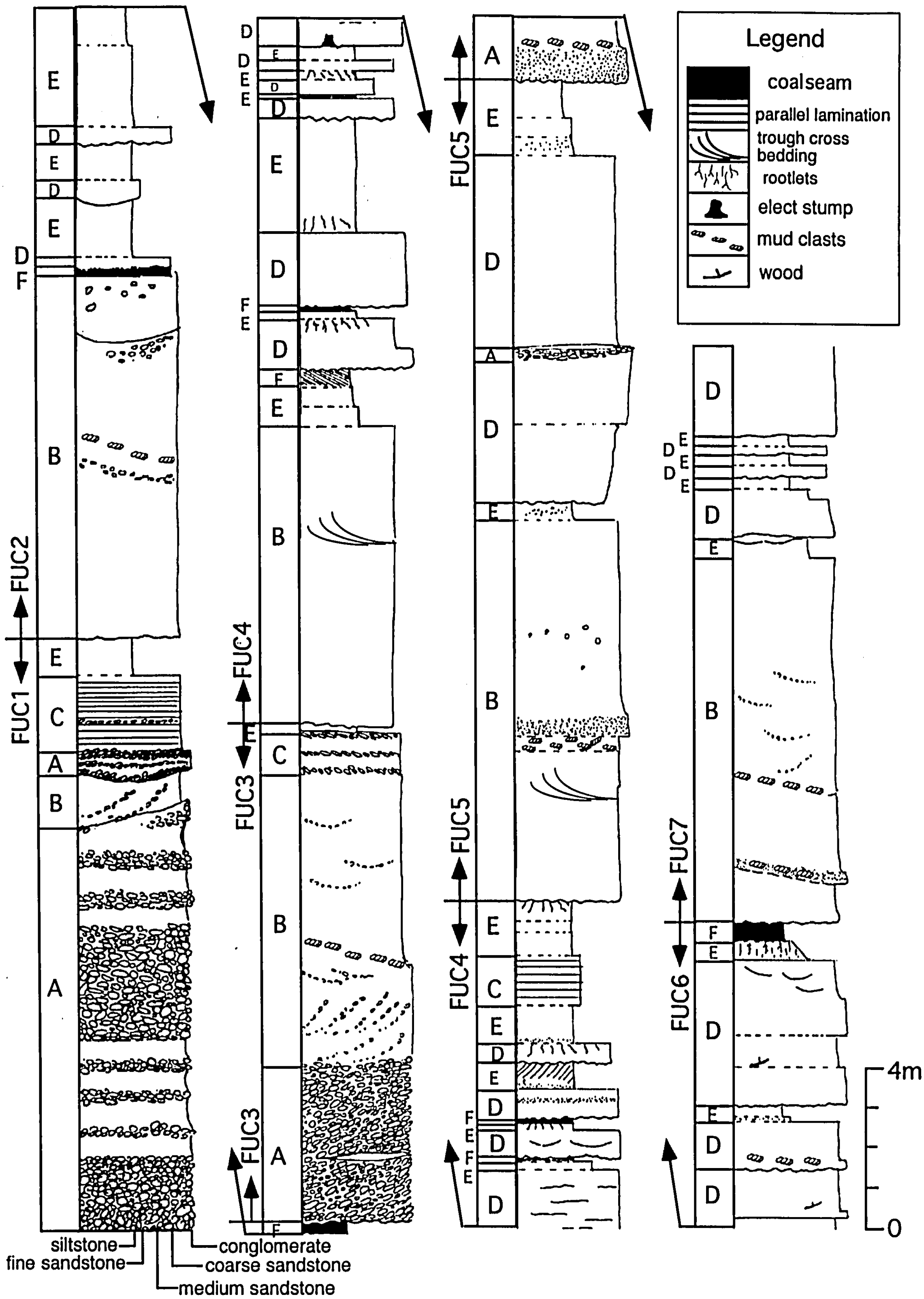

Fig. 3. Columnar section showing sedimentary facies and cycles in the Loc. 1.

Table 1. Division of sedimentary facies and interpreted depositional environments of the upper Akaiwa Formation (Tetori Group).

Facies	Lithofacies	Sedimentary structures	Environments
A	clast supported gravel,ill-sorting	massive, imbrication erosional surface on the bottom	longitudinal bedform channel floor (lag deposits)
B	pebble gravel v.c.ss.-m.ss. ill-sorting	trough and planar cross-bedding normal grading, including mud clasts	sand bar
C	v.c.ss.-f.ss	parallel-lamination	upper flow regime plane beds
D	v.c.ss-m.ss ill-sorting	massive, normal grading erosional surface on the bottom	crevasse splay
E	siltstone	massive, plantflagments, rootlets, bioturbation	flood plain
F	coal, carbonaceous mudstone	plant flagments, elect stumps	vegetated swamp deposits
G	siltstone	calcretes	soil with chemical precipitation

Facies C: parallel-laminated sandstone. Grain size is fine to very coarse-grained or pebbly. It forms beds; their thickness ranges from 1 to 2 meters.

This facies corresponds to lithofacies Sh (Miall, 1978) and is interpreted as a plane-bed flow.

Facies D: ill-sorted coarse-medium sandstone (Fig. 6). The thickness of a bed of the sandstone ranges from 20 centimeters to several meters. The beds have flat bases, which are often erosive. This facies contains wood fossils and plant fragments. The sandstone is recognized as a lenticular body in Facies E.

These features are very similar to those of crevasse splay deposits of the Cercadillo Sandstone and Siltstone Formation in central Spain (Garcia-Gil, 1993).

Facies E: gray or grayish purple massive siltstone. The thickness of a bed of siltstone ranges from 10 centimeters to several meters. Rootlets (Fig. 7), plant fragments, and bioturbation are common.

This facies corresponds to lithofacies Fsm and Fr (Miall,1978) which can be regarded as a floodplain deposit.

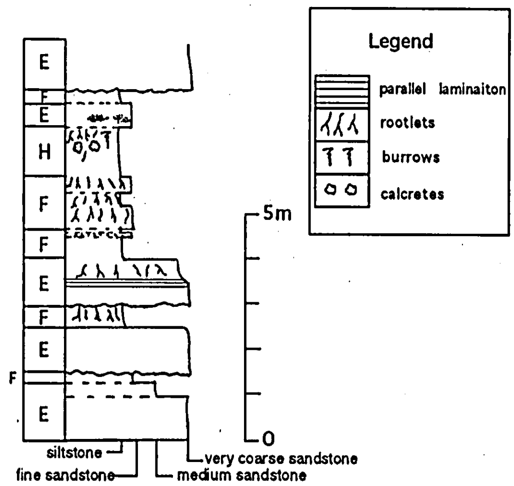

Fig. 4. Columnar section and interpreted sedimentary facies in the Loc. 2.

Facies F: coal seam or carbonaceous mudstone. Erect stumps and many plant fossils occur in this facies. The thickness of a coal seam is several tens centimeters. This facies corresponds to lithofacies C (Miall, 1978) interpreted as a vegetated swamp deposit.

Facies G: massive bluish gray siltstone. The thickness of a bed of the siltstone is about 1 meter. This facies includes rootlets and trace fossils. This facies of Loc.2 (Fig. 2. and 4) yields some calcretes. The strata of Loc. 2 is stratigraphically situated above those of Loc. 1. The calcretes appear as nodules arranged parallel to the bedding. Diameter of the nodules is 5 to 7 centimeters (Fig. 8). The nodules show dark colored branching patterns in the polished section (Fig. 9). Under a microscope, the groundmass is composed mainly of sparry calcite, micrite, and clay minerals. Texturally, the calcite is radial-fibrous (Kendall, 1985) which was initially a calcite cement filling in a void space. Floating quartz grains are distributed in the micrites. The clay minerals are mostly scattered in the margin of the nodular calcretes (Fig. 10).

This facies corresponds to lithofacies P (Miall, 1978). This facies is interpreted as a soil with chemical precipitation.

IV. Stratigraphy and cycles

Seven fining upward cycles (FUC1- 7) are recognized in the Loc. 1. The thickness of a fining-upward cycle ranges from 10 to 27 m.

FUC1 is composed of clast-supported conglomerate (Facies A) intercalating lens of very coarse sandstone (Facies B), parallel laminated sandstone (Facies C), siltstone (Facies E) in the ascending order. FUC1 may have been accumulated as gravely fluvial system.

FUC2-7 are composed mainly of sandstone and intercalating siltstone and coal seam. FUC3 exceptionally has a conglomerate in the lowest part (Fig. 5). The conglomerate is interpreted as channel lag deposit (Facies A). FUC2, 4, 5, and 7 are low angle planar cross-beds of the Facies B. Mud clasts and pebbles are arranged along the planar cross-beds. The low angle planar cross-beds can be regarded as lateral accretion of the deposits resulting from lateral migration of point bars. In the upper part of each fining upward cycles, crevasse spay deposits (Facies D) are commonly recognized in the flood plain deposits (Facies E). These cycles indicates that they are accumulated in a sandy meandering river.

Well developed coal seam and carbonaceous mudstone may suggest humid climate. On the other hand, calcitic paleosols are most typical of oxidizing conditions under arid to semiarid climates (Miall, 1996). Therefore, there was an arid phase during sedimentation of the upper part

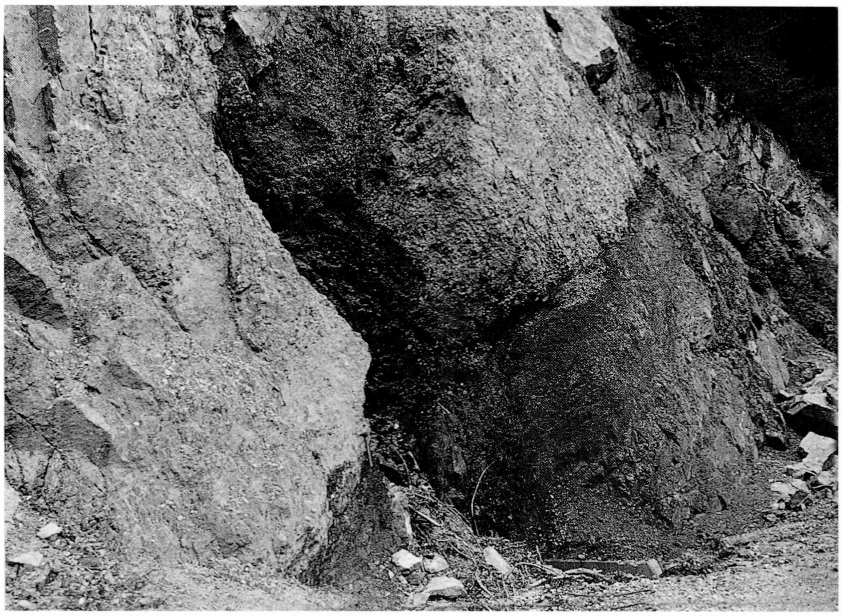

Fig. 5. Erosional surface at the base of FUC3. Dark color part is coal and carbonaceous siltstone.

Fig. 6. Crevasse splay deposits (Facies D) in upper part of the FUC4.

Fig. 7. Rootlets in the fine sand-siltstone (Facies E) of the FUC6.

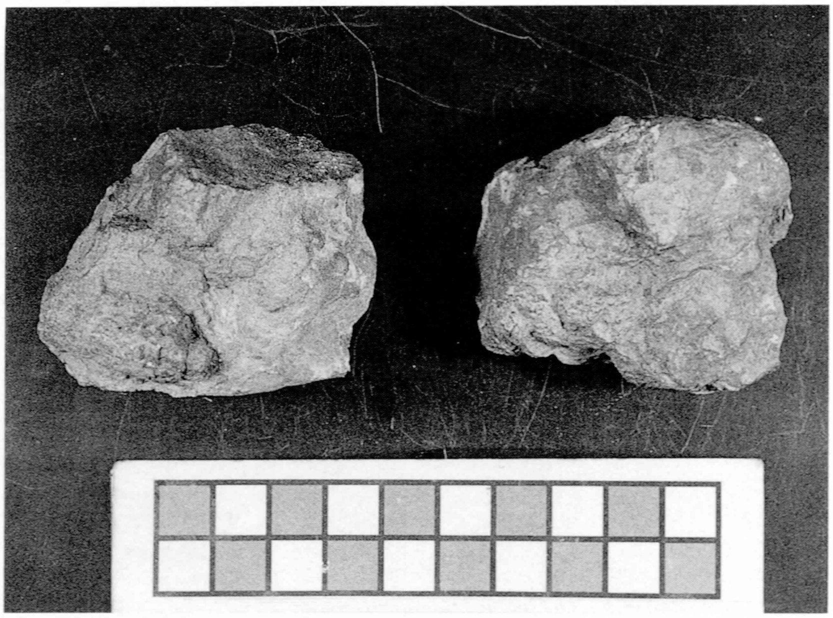

Fig. 8. Nodular calcretes of the Loc. 2. Scale is 10 centimeters in length.

Fig. 9. Polishied section of the nodular calcrete. Scale is 5 centimeters in length.

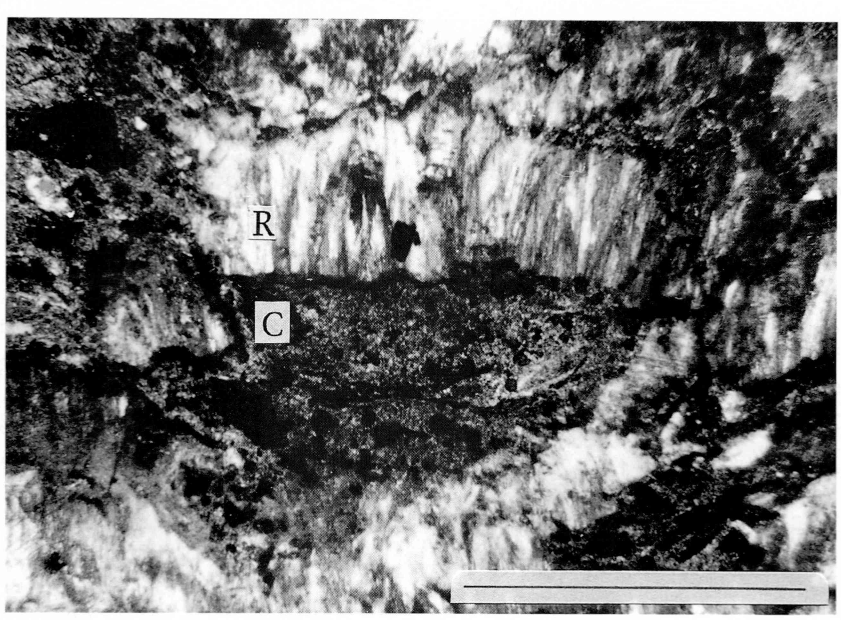

Fig. 10. Thin-section photomicrograph of the nodular calcrete showing radial-fibrous calcite (R) and clay minerals (C). Scale bar is 1 millimeter in length.

of the Akaiwa Formation. Further consideration is needed, whether the climate was semi-arid or it changed from humid to arid.

V. Conclusions

1. Seven sedimentary facies were recognized in the upper part of the Akaiwa Formation in the study area.
2. Seven fining upward cycles with an erosional base were recognized in the Loc. 1.
3. FUC1 (lower most cycle) was accumulated in a gravely fluvial system.
4. FUC2-7 were accumulated in a meandering river.
5. Nodular calcretes in the paleosols of the Loc. 2 show that there was an arid phase during sedimentation of the upper part of the Akaiwa Formation.

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