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GEOTECHNICAL - NEOTECTONIC FOUNDATION CONDITIONS OF THE MENDENITSA CASTLE (FTHIOTIDA, CENTRAL GREECE)

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ABSTRACT

Investigation in the vicinity of Mendenitsa (Lokris, central Greece) showed that the 13th century AD castle is built on an dolomitic horst that forms part of the northern marginal fault system of Mt. Kallidromo. Detailed geological mapping showed that the horst is bounded by active faults with wide cataclastic zones developing along them. Thus, foundation conditions are aggravated by the combined activity of neotectonics and adverse lithology. A number of measures to be taken is suggested so as to preserve and restore the castle of Mendenitsa.

KEY WORDS: Kallidromo, neotectonics, active faulting, Lokris, Mendenitsa

1. INTRODUCTION

The castle of Mendenitsa was built in the 13th century AD, on the ruins of a pre-existing construction, of the Classical - Hellenistic times, (or even older, according to Moraitis, 1966). It comprises two series of walls; parts of the outer one can be found within the village, while the inner enclosure forms the actual castle. The acropolis overlooks the basin of Lokris that stretches between Mts. Kallidromo and Knimis, the Northern Evoikos and Maliakos Gulfs, and the straits of Orei (Fig. 1). This location offered certain strategic advantages in the past, so the castle was of particular importance, especially in the Byzantine period and the centuries of Frank and Ottoman occupation.

The current state of the building is quite decadent, and various parts of it are on the verge of collapse, while land use in the vicinity has deteriorated its state.

The castle is built on a 560 m. elongated high hill ('acropolis')(Fig. 1). To the north and east lies the Lokris basin, while to the south rises Mt Kallidromo. Between the mountain and the acropolis is a well-developed plateau, bounded and/or interrupted by some hills. A few kilometres west of Mendenitsa rises Mt. Elafovouni, while tributaries of the Latzoremma torrent dissect the landscape between the acropolis and the mountain.

2. GEOLOGY - GEOTECHNICAL DATA

The hill on which the castle is founded consists of triassic dolomites and dolomitic limestones (Celet, 1962) that belong to the Sub-Pelagonian Unit. To the south, the carbonates come in tectonic contact with the Mendenitsa formation (Fig. 1b). The latter comprises consolidated breccia (locally conglomeratic breccia), probably of Günz age, according to Philip (1974) or Würm age (H. Schneider, pers. comm.). The breccia is heterometric and monomictic, consisting solely of carbonate 2-10 cm. clasts (mainly triassic dolomites, but also limestones), cemented by cohesive red clay and silty clay. To the east and northeast, the carbonates are faulted against the fluvio-lacustrine fill of Lokris basin (Plio-Pleistocene), while to the

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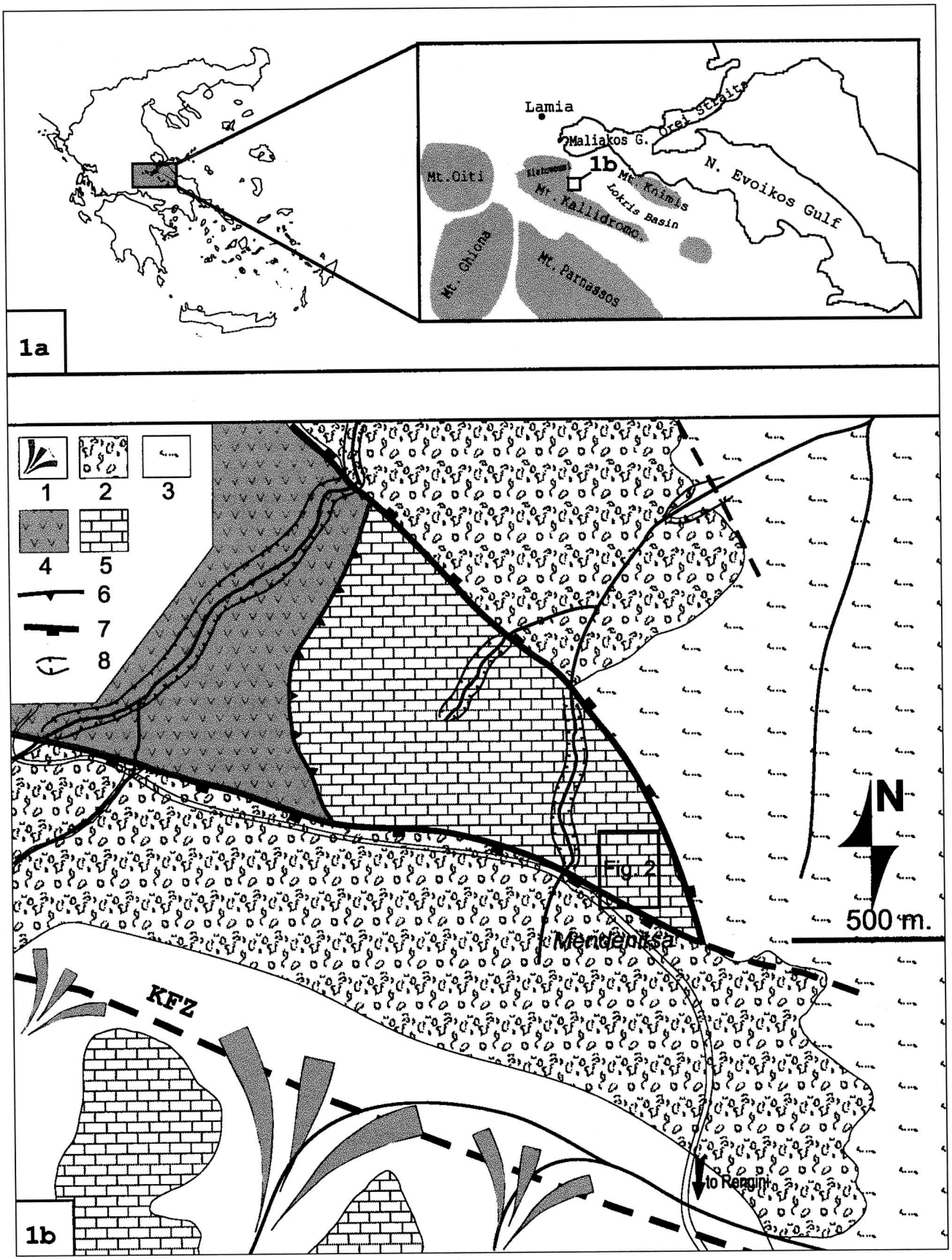

Fig. 1a: Location map, showing place names referred to in text.

Fig. 1b: Geological map of Mendenitsa and environs; main drainage also shown.

1. Alluvial apron and scree (Late Pleistoce - Holocene); 2. Mendenitsa formation; 3. Fluvio - lacustrine sedimentes (Plio - Pleistocene); 4. Ophiolites; 5. Dolomites; 6. Thrust; 7. Fault; 8. Stream incision.

KFZ: Kallidromo Fault Zone.

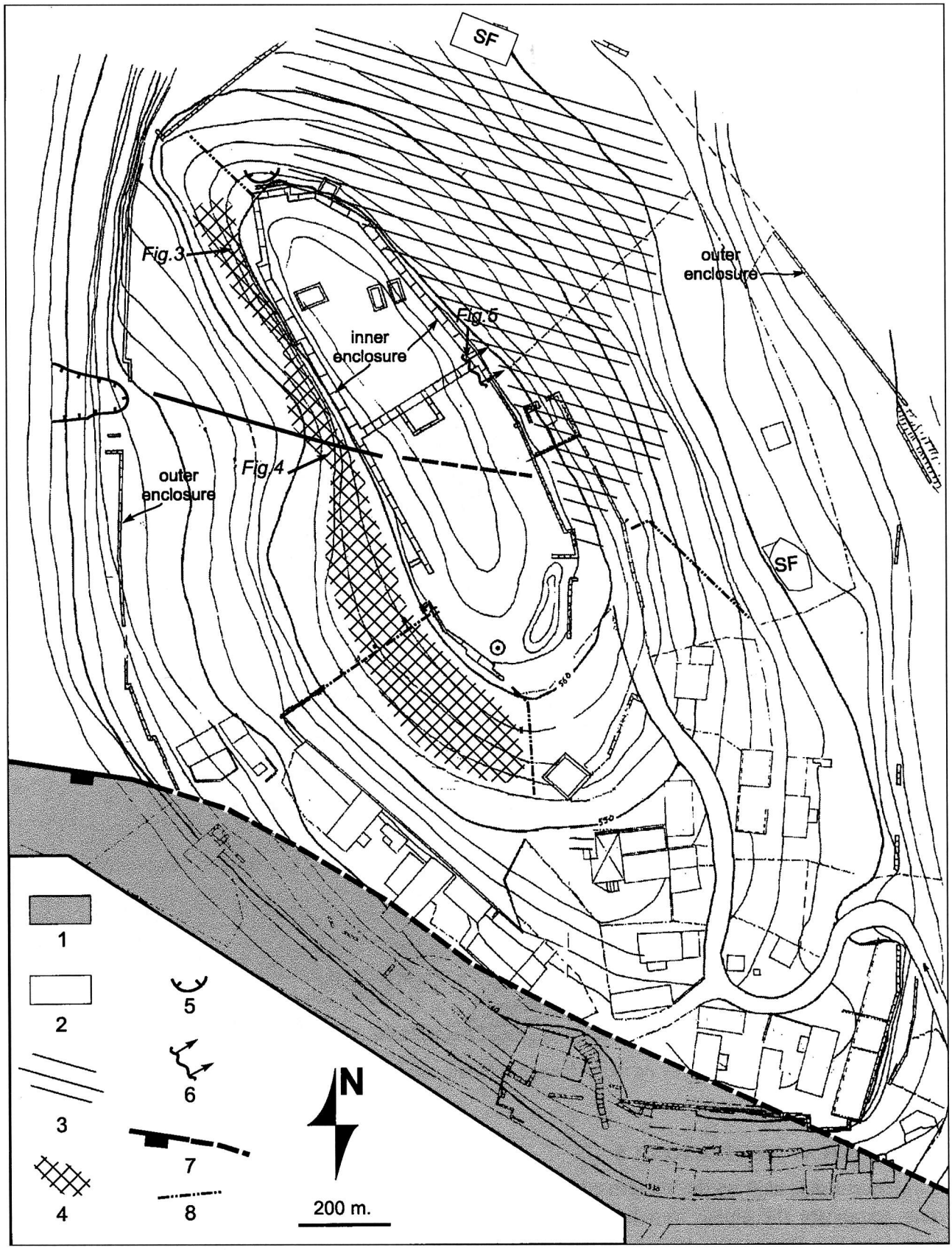

Fig. 2: Geologic - tectonic map of Mendenitsa horst. 1. Mendenitsa formation; 2. dolomites; 3. regolith; 4. cataclasite; 5. subsidence; 6. super-structure fracture and displacement; 7. fault; 8. wire fencing; SF: sheepfold. Contour interval: 2m.

north they are juxtaposed against the Mendenitsa formation again. To the west, the dolomites are thrust over an occurrence of the ophiolitic complex of the Sub-Pelagonian Unit (mainly peridotites in this area). All the boundaries of the triassic carbonates in the area of Mendenitsa are tectonic.

Geotechnically speaking, the carbonates have quite negative characteristics, contrary to the Mendenitsa formation. The former are highly tectonised and literally pulverised at various locations, especially along the northeastern and southern boundaries of the dolomites. On the other hand, the Mendenitsa formation is generally very compact, except for rare bands of incohesive breccia, 5-10 cm wide, and bears few signs of dissolution and/or karstification.

The castle has been founded on the tectonized dolomites (Fig. 3). On the northeastern slope of the acropolis occurs a 10-30 cm.-thick regolith, stabilised by the existing shrubs and other plants. This regolith is less developed on the southwestern slope, mainly because of the increased gradient there. At the same side of the hill, the terrain is craggy, with outcrops of the unweathered dolomites protruding all over the slope.

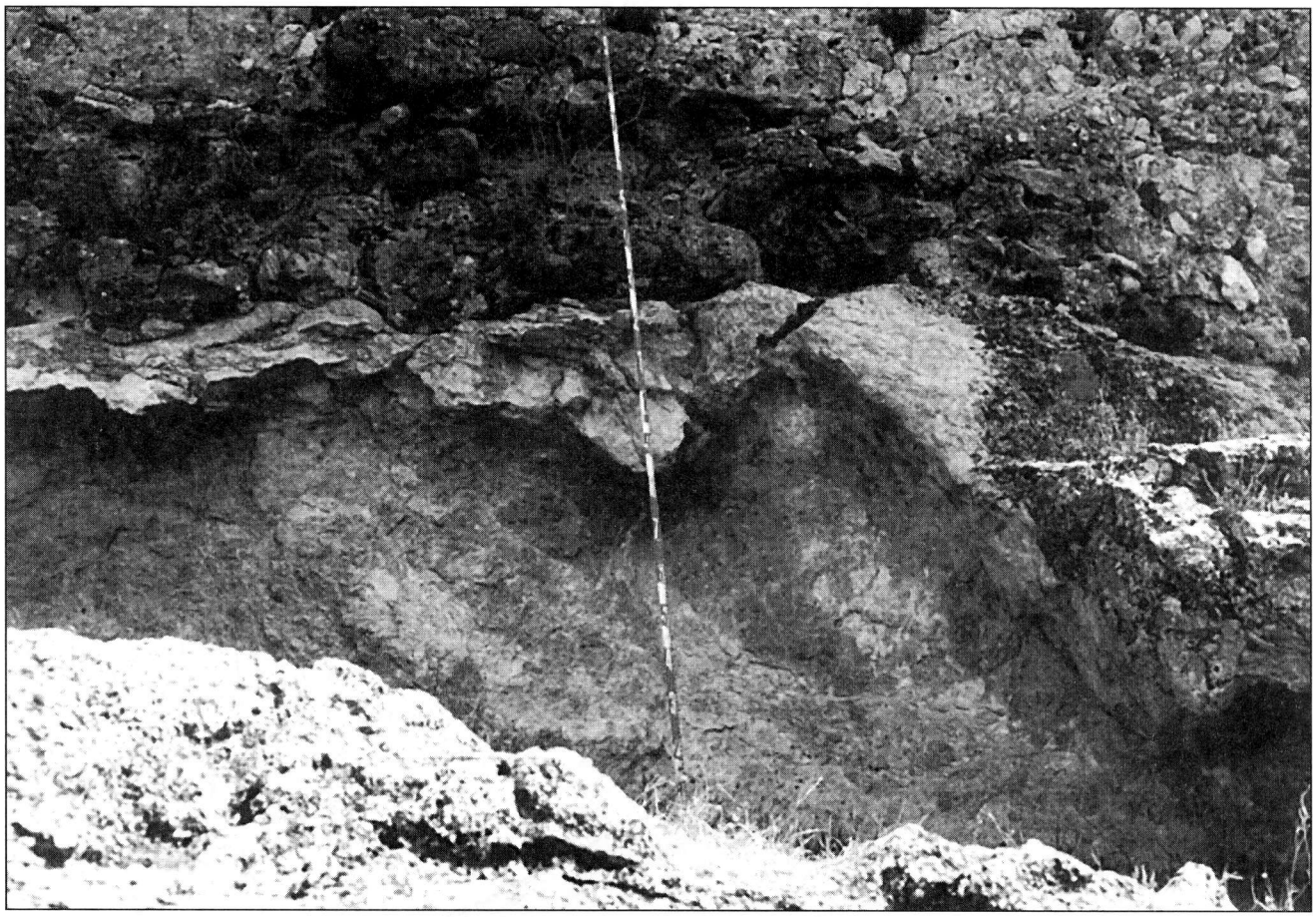

Fig. 3: Foundation of castle directly on the tectonised dolomite (cataclasite). 2-m. rod for scale. For location of photo see fig. 2.

3. TECTONICS – NEOTECTONICS

Mendenitsa is built on the western edge of the tectonic northern margin of Mt. Kallidromo. This fault zone juxtaposes the alpine formations of the mountain (Triassic-Jurassic carbonates and ophiolites) against the Plio-Pleistocene deposits of the Lokris basin. It is a composite fault zone, of mean WNW-ESE trend, parts of which are considered active. Talus cones and scree of Late Pleistocene - Holocene develop all along the central and western parts of the fault zone, from Rengini, which lies 9 km to the east, to Mendenitsa, forming a large colluvial apron that south of the village buries the Mendenitsa Formation.

In In the immediate area of the village (and the castle), two are the prominent tectonic features.

The first has a NW-SE trend and actually forms the northeastern boundary of the acropolis (Fig. 1b). It

is part of a large fault zone, of which the northwesterly prolongation forms the western margin of the Lokris basin. The kinematics of this fault are not clear, but field observations and mapping in the wider area have shown that it is oblique-normal (*sensu* Mariolakos and Papanikolaou, 1987). The vertical throw of the fault in the vicinity of Mendenitsa is of the order of a few hundreds of metres, given that investigation drillings dug 300 metres northeast of the village (and the fault zone) penetrated 200 m. of plio-pleistocene deposits, without reaching the substratum. The activity of this fault zone is held responsible for the pulverisation of the dolomites, all along their north and northeastern boundary.

A second tectonic contact, trending WNW-ESE, juxtaposes the dolomites (upthrown block) against the Mendenitsa formation to the south (downthrown block). It is an active fault with a 5 to 25 m.-wide cataclastic zone and a striae-bearing slickenside, found about 500 m. west of the village (Karavidorahi).

These two faults create the horst of Mendenitsa, on which the castle is built. The fact that this horst is an active structure is also revealed by the study of the morphotectonic data. That is to say, the tributaries to Latzorema that flow roughly from south to north, on entering the horst they become deeply incised, while upstream (to the south) incision is almost absent (Fig.1b), a fact denoting the continuing uplift of the horst. Note that for the streams that flow immediately east of Mendenitsa (Fig. 1b) the difference in incision cannot be attributed to lithology alone, as the Mendenitsa formation is highly indurated and almost as erosion-resistant as the dolomites themselves.

A smaller-order linear tectonic feature is located within the horst. It is a WNW-ESE fracture (Figs. 2 & 4) and appears to have affected the castle itself. It has displaced and destroyed a part of the southwestern inner wall and may be responsible for the collapse of a large portion of the southeastern inner wall.

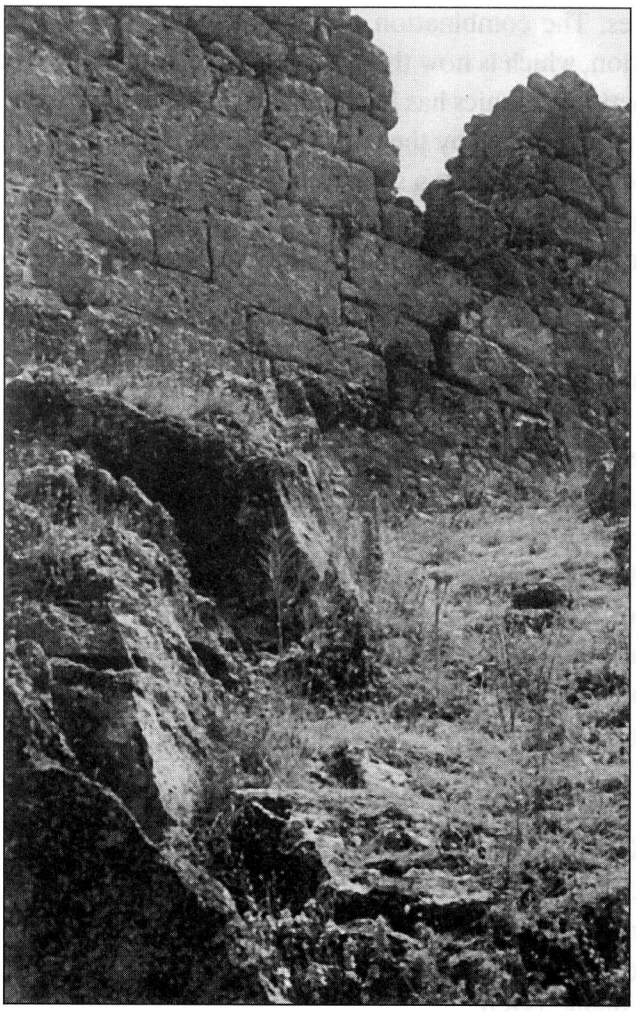

Fig. 4: Fault within the Mendenitsa horst, affecting the superstructure. For location see fig. 2.

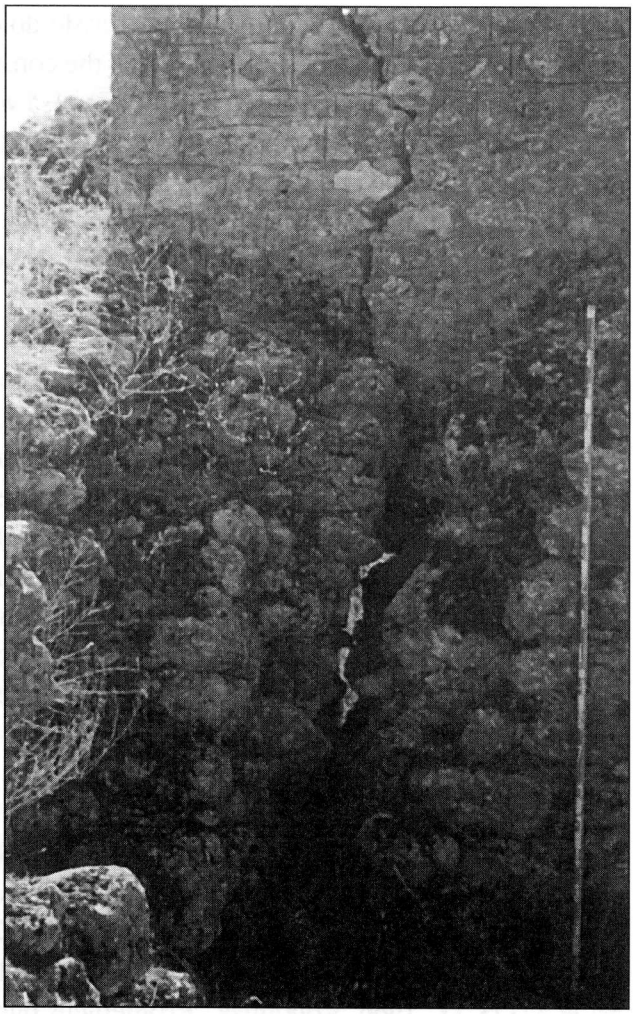

Fig. 5: Active fracture within the the superstructure. 2-m. rod for scale. For location see fig. 2.

4. LITHOLOGY - PATHOLOGY OF THE SUPERSTRUCTURE

As mentioned above, the 13th century castle was built on the remains of an older structure. The two generations of construction are discernible, both by the form and the lithological composition of the stone-masonry. The older generation consists of large, oblong-shaped stones, measuring up to 1*0.5*0.5 m. These stones were quarried from the Mendenitsa formation, and have been fitted without the use of any type of mortar or plaster. The younger generation consists of smaller, irregular stones, usually less than 0.4 m long that have been fitted together and a number of ceramic fragments has been inserted in the joints, so as to ensure stability. Rebuilding in the 13th century also involved restoration of the better preserved ancient remains, so the same type of mortar with ceramic fragments has been used locally to enforce parts of the older generation.

The castle has suffered extensive and repeated damage, both by natural and man-induced causes. Joints have loosened up at various places, while other parts are still collapsing. A portion of the northeastern wall is prone to total collapse, because of a well-developed fracture that has affected both the superstructure and the foundation (Fig. 5), and seems to be related to creep of the regolith on the northeastern slope. Aseismic activity of the fault zone may also have contributed to this feature.

The main tower also faces the danger of complete collapse, while local subsidence is observed at the northwestern edge of the castle (Fig. 2) and must have been caused by a collapsed tunnel dug to connect the castle with the nearby village (Karavidia).

5. DISCUSSION - CONCLUSIONS

Detailed geological mapping in Mendenitsa and observation in the wider areas showed that the castle is built on an active horst, composed of triassic dolomites. The combination of geologic-geotechnical and man-induced factors has seriously affected the construction, which is now threatened now by total collapse.

Deep ravine incision, caused by, and coupled with active tectonics has led to undercutting and removal of material from the slopes of the acropolis. This effect is aggravated by the condition of the dolomites that are highly tectonised and weathered, and are far from being regarded as a solid foundation formation.

As regards the superstructure itself, successive ravages, as well as an unfortunate restoration attempt about twenty-five years ago –which mainly involved cementation of joints-, have caused its severe deterioration.

The following measures are suggested:

- The restoration of land use around the castle, that is removal of the sheepfolds and of wire fencing between the two enclosures.
- Stabilisation of the slope, with any appropriate means (mainly plantation)
- Instrumental monitoring of the fault that affects the superstructure itself, so that all necessary steps can be taken to avoid further negative consequences by fault creep.
- Immediate restoration works on the foundation of the northeastern wall and sealing and reinforcement of the fracture that threatens this part with total collapse.

Another point related to the overall conditions around the castle has to do with the access to it. Currently, the visitor has two options: either to climb a flight of dilapidated stone stairs, or to follow a footpath that literally crosses the backyard (!) of a cottage.

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