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Reply to comment on Deformation of the Lower Cambrian sequence in the Sandıklı region (Afyon), central Turkey by S. Gürsu and M.C. Göncüoğlu

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1. Introduction

I thank Drs Gürsu and Göncüoğlu for their interest in my work [1] and for providing me an opportunity to additional data to clarify my interpretation about " kinematic analysis " of the Lower Cambrian sequence in the Sandıklı region (Afyon) in central Turkey. With their comment, Gürsu and Göncüoğlu [2], dispute about field observations, geological mapping and petrographic/microtectonic features of the Lower Cambrian sequence in the Sandıklı region. However rather than a discussion about "structural elements and kinematic analysis" of the Lower Cambrian sequence, which was the main point of my paper [1], their comment is reminder of their conception [2, and references therein in which they are included as author and co-author] of the geology and regional interpretation of the Lower Cambrian sequence in the Kocayayla and Taşoluk areas in the Afyon region. So my reply is a kind of repeating why I do not agree with their interpretation. I also welcome the opportunity to summarize my point of view about descriptive (geometric) and kinematic analyses of the Lower Cambrian sequence in the Sandıklı region.

2. Descriptive analysis (Field observations and geological mapping)

Figure 1 of Gürsu and Göncüoğlu [2] gives correlation of the Lower Palaeozoic and the socalled Neoproterozoic units in the Central and eastern Taurids. My work [1] is not related to establish the lithostratigraphy of the Lower Cambrian sequence in the Sandıklı region.

Lithostratigraphy of the Lower Cambrian sequence have been described by Erdoğan *et al.* [3] and alternatively by Gürsu and Göncüoğlu [2, and their references therein]. In addition to that, correlation of the Lower Cambrian rocks in the Taurids was not topic of my work. Geological mapping is the hearth of the descriptive analysis of the structural geology. The geological map shows distribution and boundary relations of the rock units. Figure 2 of Gürsu and Göncüoğlu [2, and references therein in which they are included as author and co-author] give geologic map of the Lower Cambrian sequence in the Kocayayla area to the southwest of Sandıklı. These maps contain omission of some rock units and false interpretations of the boundary relations. First, around Sığırkuyruğu Tepe located to the west part of the Kocayayla area, the characteristic outcrops of the Celiloğlu formation are found (Fig. 1a), however their latest map [2, Fig. 2] do not contain the Celiloğlu formation to the west of the Kocayayla area.

The Celiloğlu formation is composed of alternations of gray and green metapelites and violet metapsammites with abundant deformed trace fossils (Fig. 1b, c). Second, boundary between the Lower Cambrian sequence and the Early Jurassic İlyaslı formation mapped as thrust fault by Çakmakoğlu [4] and Gürsu and Göncüoğlu [2, figure 2] in the area between Menteş and Yumruca village. However, the base of the Early Jurassic İlyaslı formation is an unconformity

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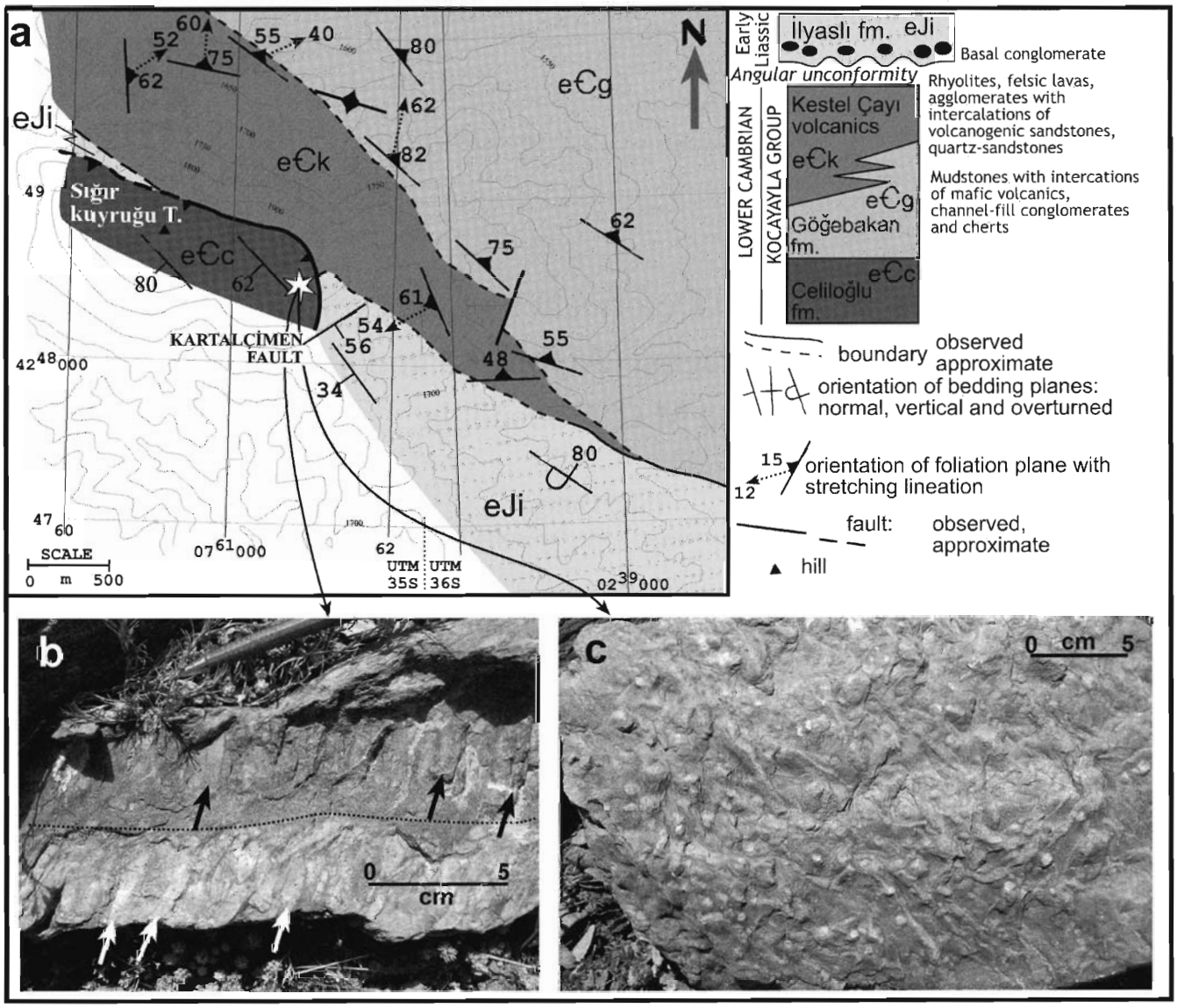

Fig. 1: **(a)** Deatiled map showing the Celiloğlu formation, Göğebakan formation and Kestel Çayı volcanics of the Kocayayla group and the unconformably overlaying Early Jurassic İlyaslı formation around Sığırkuyruğu Tepe to the west of the Kocayayla area. The Celiloğlu formation tectonically overlays the Kestel Çayı volcanics and the İlyaslı formation. **(b)** metapsammites with abundant trace fossils in the Celiloğlu formation. Photograph show the section of the bed. Arrows indicate tube shaped trace fossils. Dashed line indicate bedding plane. **(c)** View of tube shaped trace fossils on the bedding plane. For way-up indication see Erdoğan et al. [3, figure 7b].

and is locally overturned in the area between Kocakarakaya Tepe and Sığırkuyruğu Tepe (Fig. 2), and in normal position to the west of Yumruca Village (Fig. 3). In this overturned area (Fig. 2) Çakmakoğlu [4] and Gürsu and Göncüoğlu [2] combine the intercalations of volcanosedimentary rocks containing red tuffaceous matrix of the Early Cambrian Göğebakan formation with red conglomerates of the İlyaslı formation. So, the boundary between red volcanosedimentary rocks of the Göğebakan formation and the overlaying rhyolites was inexactly mapped as a thrust. In this locally overturned limb, the bedding planes of the conglomerate sequence in the İlyaslı formation dip more steeply than the spaced cleavage planes, however, the red volcanosedimentary beds of the Göğebakan formation show a prominent penetrative linear fabric and foliation marked by elongated and flattened volcanogenic clasts. These structural elements of the Göğebakan formation are consistent with other outcrops of it in the Kocayayla area. Third, the boundary between the Lower Cambrian Göğebakan formation and the Kestel Çayı volcanics was interpreted as an unconformity surface [2]. However this boundary does not show the characteristics of an unconformity in the area to the west of Yumruca village (Fig. 3). The so-called basal conglomerates represent an activity of deformation and erosional interval, however, the primary structures of the Kestel Çayı volcanics and the Göğebakan formation are concordant each other in this area (Fig. 3). The so-called basal conglomerates [2, Fig. 4b] have no matrix of same lithology with the overlaying Göğebakan formation, and are misinterpretation of an

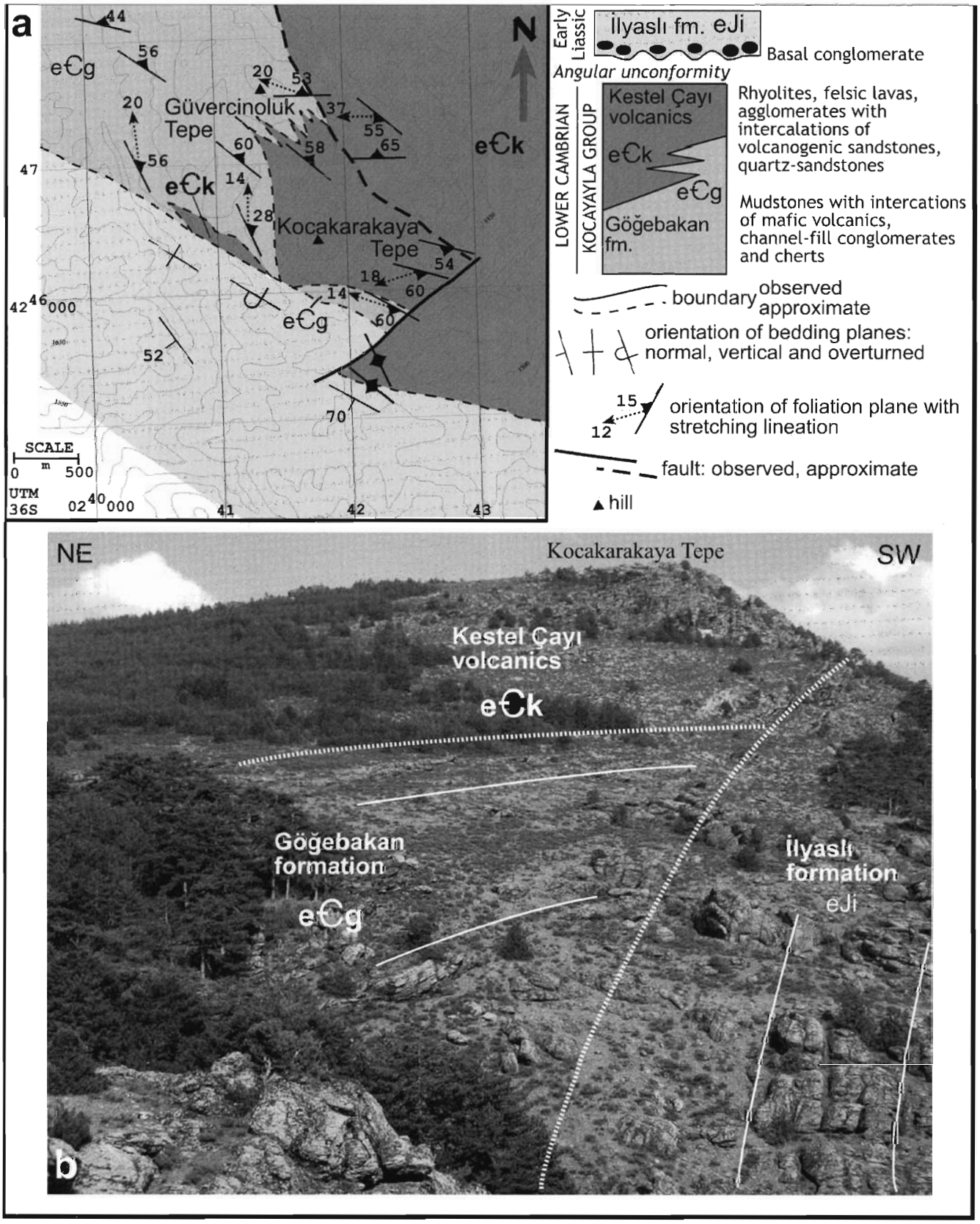

Fig. 2: **(a)** Detailed map showing boundary relation between overturned limb of the unconformity along the base of the Early Jurassic İlyaslı formation. **(b)** Photograph showing the field view of the unconformity between the Kocayayla group and the İlyaslı formation. Dashed lines indicate boundaries of the rock units, and solid lines indicate attitude of the internal structures of the rock units.

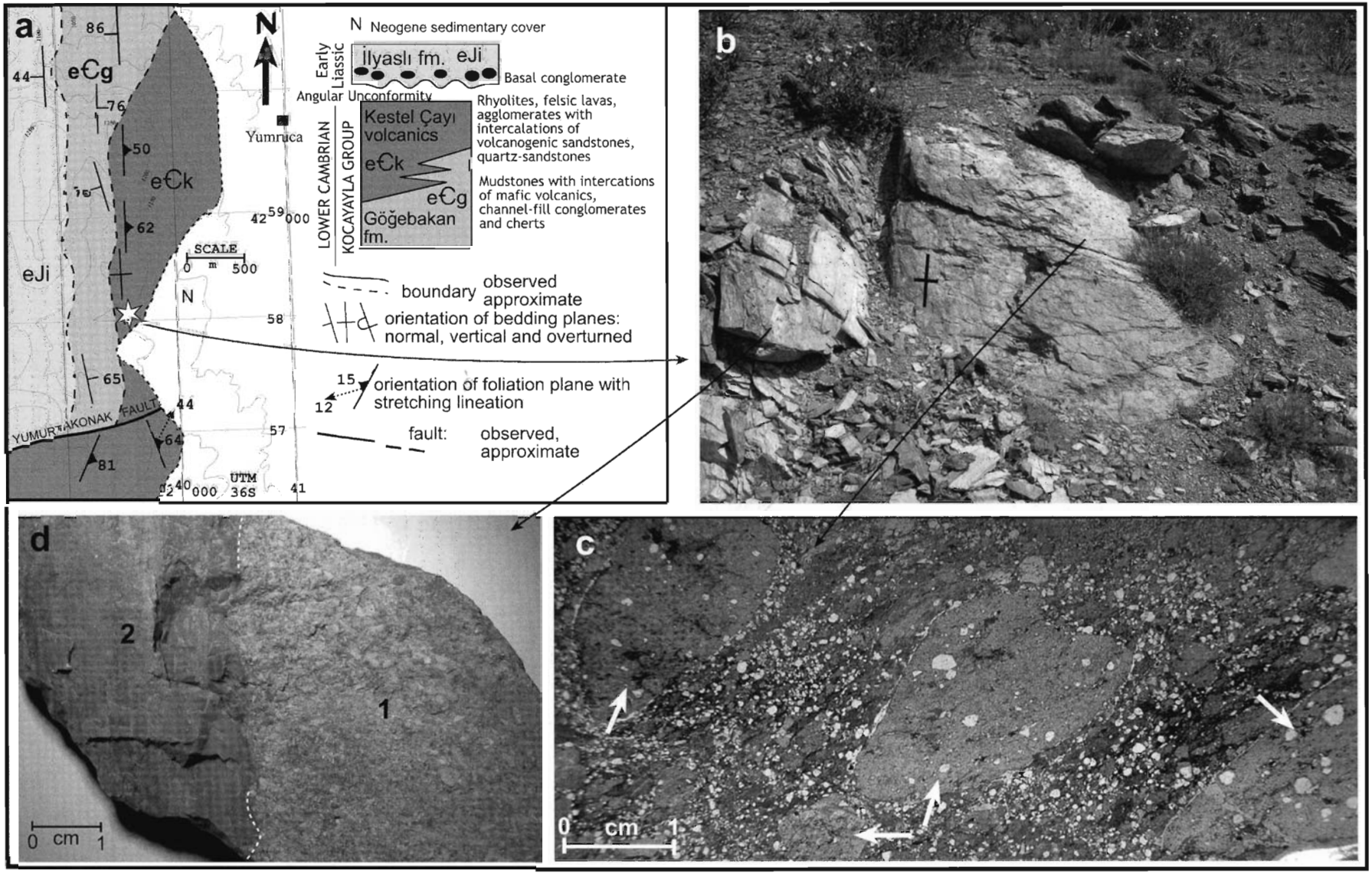

Fig. 3: (**a**) Detailed map showing the Kestel Çayı volcanics, the Göğebakan formation and the unconformably overlaying İlyaslı formation to the west of Yumruca village. (**b**) Field view of vertical beds of the felsic hyaloclastics of the kestel Çayı volcanics along the boundary with the Göğebakan formation. (**c**) Close view of the felsic volcanoclastics with tuff matrix. Note that the clasts show characteristics of the porphyritic texture with no deformation. Arrows indicate large clast in felsic volcanoclastics. Photograph was taken from large thin section. (**d**) Phograph showing conformable boundary relation between relatively fine grained felsic hyaloclastics (1) and silicified mudstone and shales (2).

volcanogenic clastics along the transition zone between the Kestel Çayı volcanics and the Göğebakan formation (Fig. 3b). These beds are typical felsic hyaloclastites with matrix of rhyolitic tuffs (Fig. 3c), and some clast in these hyaloclastites have primary, thin flow foliation that can be confused in thin sections with the deformed rhyolite.

Without a precise descriptive analysis, trying the regional correlation, establishing the deformation phases/events and kinematic analysis of the rock units would fail. Three deformation phases suggested by Gürsu and Göncüoğlu [2] in the Kocayayla area is inconnected with the systematic measurements and descriptions of the mesoscopic structures.

3. Kinematic analysis (Petrographic and microtectonic features)

It is a clear confusion that figure 9c and d in my work [1] was considered as the microphotographs of microgranite and quartz-porphyry by Gürsu and Göncüoğlu [2]. These figures show the "deformation stages" of the feldspar phenocrysts set clearly in mylonitized matrix. I prepared more than 200 thin sections both random for petrographic analysis from less strained part of the rhyolites and oriented for kinematic analysis. Random ones give characteristics of porphyritic texture with euhedral quartz and feldspar crystals set in glassy matrix indicating extrusive setting of the rhyolites. In addition to that, mylonitic rhyolites also contain as porphyroclast of preserved quartz phenocrysts with embayment textures [1, Figure 7b]. Figure 9c in my work [1] show a detached feldspar phenocryst in mylonitic matrix.

Pressure shadows in and around this detached phenocryst were filled by tiny quartz and serisite. This confusion indicates that Gürsu and Göncüoğlu [2, and their previous studies about Sandıklı region] have handicaps in petrographic and kinematic analyses of the rhyolites.

Besides, Gürsu and Göncüoğlu [2, Fig. 6] presented microphotographs of crenulation cleavages in metapelites of the Göğebakan formation including thier Güvercinoluk formation and rhyolites in the Kestel Çayı volcanics. Unless the structures in microphotograps supported by field observations, they are defective data. Deformation phases can be distinguished by describing their set of associated structures and their cross- cut relations. And we need care to establish the deformation phases/events. Overprinting relations may be produced by a single deformation phase [5, page 4] and, random thin sections and structures on the random surfaces of the outcrops do not help to define the structural history. Non of the previous studies about the Kocayayla area describes the structural elements of the Lower Cambrian sequence, but my work [1] displayed a penetrative deformation of the Lower Cambrian Kocayayla group before depositon of the trilobite-bearing Middle Cambrian sequence. This penetrative deformation produced a set of structures with consistent orientation in the Kocayayla area, and overprinting deformation is not penetrative, but rotations inferred by the orientation of the overlaying sedimentary units. Stratigraphic relations and orientation of the structures related to the penetrative deformation do not indicate any disconformity in the Kocayayla group. From the point of descriptive and kinematic analyses, my work [1] is acontribution to the geology of the Lower Cambrian sequence in the Sandıklı region.

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