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Comment on: "Late Cretaceous extensional denudation along a marble detachment fault zone in the Kırşehir massif near Kaman, Central Turkey" by C. Lefebvre et al., 2011 DOI: 10.1016/j.jsg.2011.06.002

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1. Introduction

For long time, Central Anatolia was believed to be a region undergoing compressional tectonics following the Late Cretaceous closure of the Tethys Ocean. Gautier et al. (2008) who studied the ductile domain of the Niğde core complex discussed the Niğde exhumation in terms of compression and extension. Genç and Yürür (2004), Yürür and Genç (2006), and Genç and Yürür (2010) structurally described the detachment faults not only from the Niğde Massif but also from several other locations in central Anatolia to propose that the region underwent crustal extension since Late Cretaceous time. One of the important conclusions of Genç and Yürür (2010) is that the suture lines now observed in Anatolia have to be reconsidered with regard to displacements that the suture lines may have experienced due to this extensional regime. A new paper by Lefebvre et al. (2011), was recently published dealing with the tectonics of the Kırşehir Massif entitled "Cretaceous extensional denudation along a marble detachment fault zone in the Kırşehir massif near Kaman, Central Turkey". The paper mainly discusses the "Kaman fault zone" using calcite deformation fabrics of the marbles. Applying calcite fabrics and geochronological data from the literature, they propose a geotectonic model in four stages for the Kırşehir metamorphics. The purpose of this comment is to point out a number of incoherencies in the paper of Lefebvre et al. (2011). We have numbered these for convenience.

2. Kaman fault

(1) The Kaman Fault is described in the paper as "The first extensional detachment described from the northern Central Anatolian Crystalline Complex (CACC). This is not strictly true since, if Seymen (1981) was the first to describe the fault zone west of Kaman as a thrust fault, Okay and Tüysüz (1999) wrote that "it could be a detachment fault with a normal sense of displacement, which allowed the exhumation of the metamorphic rocks". Genç and Yürür (their figure 17, 2010) mapped this fault as a second-order normal fault dipping towards the WSW, and associated it with the NW-SE trending first-order extensional fault zones of central Anatolia. The Kaman fault is therefore not the first detachment fault described. In this region, the first detachment faults described were the Kırşehir and Savcılı detachment fault zones (Genç and Yürür, 2004, 2010; Yürür and Genç, 2006). The nature of the Savcılı detachment zone is not debated as Lefebvre et al. (2011) suggest. The Savcılı thrust fault, first defined by Seymen (1981), is a secondary feature in this detachment fault zone (Genç and Yürür, 2004, 2010; see particularly Yürür and Genç, 2006) and there is no contradicting opinion published which is dealing with the Savcılı detachment fault zone. Other detachment zones in CACC such as the Sorgun, Karanlıkdere, Kozaklı, Kızılırmak and Tuz gölü zones were described previously by Genç and Yürür (2010; Figs. 17 and 18). (2) Some observations and interpretations on the Kaman fault are not consistent with field data: for structural evidence from the ophiolitic hanging-wall of Kaman fault, observations were not made directly at the detachment fault surface but within gabbroic rocks 15 km from the fault on the right bank of the Kızılırmak River at the Hirfanlı dam. That these gabbroic rocks are part of an ophiolitic suite is a point of debate. The authors describe the plutonic rocks as "… granites and intrusive gabbros … located to the west of Kaman"

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(p. 1224). The text and maps they present, however, suggest that basaltic rocks directly overlie the detachment fault surface.

Despite this cartographic evidence, the authors claim that "there are… no exposures of the ophiolitic sequence closer to the contact with the Kırşehir metamorphics that would allow a further study of its deformation history" (p. 1225). It is not clear why data were not obtained from the basaltic rocks at the contact with the detachment fault but rather from gabbros, supposed to belong to the hanging-wall block, and whose origin is still controversial. (3) The structures described as extending parallel to the foliation and presented as "megabreccias" (page 1 and figs. 7C, D, E), are not tectonic breccias as the authors suggest, but karstic solution breccias. This is clear from their matrix descriptions, and also from the presence of graded and cross-cutting lamination of the fine-grained matrix in between clasts, typical for karstic solution breccias. These solution breccias are frequently found in marbles throughout the Kırşehir Massif (e.g. around the villages of Sıddıklı, Çayağzı and Terziali). They form in near-surface environments and are related to circulation of meteoric water. In addition, these solution breccias are not limited to fault zones and metamorphic rocks. They are also frequently observed in Eocene and Neogene carbonates overlying the metamorphic rocks, and reflect Late Miocene-Pliocene karstic processes in the Kırşehir Massif (Genç, 2006). Even if these breccias were of tectonic origin, they are very young (Mio-Pliocene) and cannot be used as evidence for Cretaceous exhumation events. On the other hand, even if we would accept that these young karstic processes are controlled by the Kaman fault zone, then the Kaman fault must also be of Mio-Pliocene age and therefore could not be related to Cretaceous exhumation of metamorphic rocks. Clearly, it is dangerous to infer "extensional tectonics" from the study of only a single fault.

3. Exhumation and extension in central Anatolia

(4) Lefebvre et al. (2011) refer to the work of Burkhard (1993) when interpreting calcite twinning. According to Burkhard (1993), calcite twinning is produced at greenschist facies or lower grade P-T conditions (<300 °C, Fig. 6 in Burkhard, 1993), and at lower temperatures in major fault zones. Metamorphic conditions in the study area reached 700–750 °C (Fig. 3 in Lefebvre et al., 2011). Therefore calcite twinning textures are likely only related to late phases of exhumation. The method Lefebvre et al. (2011) used is therefore not appropriate to explain the geotectonic evolution of domains with high temperatures.

(5) Lefebvre et al. (2011) claim that the detachment faulting between metamorphic rocks and ophiolitic rocks ceased with granitic intrusion in the Late Campanian (pp. 1233–1234 and fig. 10). Genç and Yürür (2010), however, described in detail several detachment zones affecting granites and metamorphic rocks from the Kırşehir, Niğde and Yozgat regions. Furthermore, the authors accept the existence of ductile extensional shear zones in the granitic batholiths described in previous publications. If they do accept this, they should also accept that detachment faults were active after the emplacement of granitic rocks. According to Genç and Yürür (2010) exhumation and extension in central Anatolia did not finish in the Paleocene as proposed by Lefebvre et al. (2011), but is actually still active.

(6) The authors claim that "At the scale of the CACC, there is no systematic relationship between the position in the metamorphic unit and the metamorphic grade" (p. 1234). This is incorrect, because the authors erroneously think that the Kaman metamorphic rocks and Bozçaldağ marbles represent the upper levels of the Kırşehir Massif. Based on the new metamorphic stratigraphy of the Kırşehir massif proposed by Genç (2003), the Kaman metamorphites and Bozçaldağ marbles represent the lower levels. Therefore, there is no inconsistency between the metamorphic grade and stratigraphic positions of the metamorphic rocks. In Fig. 3 all marble levels in different metamorphic units are given as Bozçaldağ Formation, but this is also incorrect.

(7) In the Synthesis – discussion section (p. 1232), at the first sentence of paragraph 4, the authors credit the use of the term Kırşehir Metamorphic Core Complex (KMCC) to Genç (2004), but claim that Genç (2004) used this term to refer to a post-Middle Eocene detachment fault near the Savcılı village. Genç (2004) suggested that the gold-bearing tensional fractures postdate Late Cretaceous ductile events and are of pre-Middle Eocene age, and did not propose a link between the KMCC formation and detachment faulting.

4. Conclusions

The existence of detachment faults and extension in central Anatolia is documented by earlier studies (Yürür and Genç, 2006 and Genç and Yürür, 2010). Genç and Yürür (2010) suggest that extensional tectonics was present over a large part of the Anatolian microplate since the Late Cretaceous. They give structural evidence for large horizontal displacements of crustal sheets in central Anatolia and propose that after the Late Cretaceous formation of Kırşehir and Niğde core complexes, thin-skin extensional tectonics continued (Figure 19, Genç and Yürür, 2010) to stretch the crust in a generally NE-SW direction. From this point of view, the field data, comments and conclusions of Lefebvre et al. (2011) are not new and contain incoherencies in themselves and with data from the literature. The conclusions of the paper are unfortunately partly incomplete repetitions of data given in earlier work, and much effort could have been saved by correct reference to the available literature.

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