Geomorphology 223 (2014) 129–133

Contents lists available at ScienceDirect

Geomorphology

journal homepage: www.elsevier.com/locate/geomorph

Discussion

Reply to "Comments on "Structural–tectonic controls and geomorphology of the karst corridors in alpine limestone ridges" by L. Tîrlă and I. Vijulie, Geomorphology 197 (2013), 123–136" by J. Lenart and T. Pánek

Laura Tîrlă*, Iuliana Vijulie

University of Bucharest, Faculty of Geography, Department of Regional Geography and Environment, Romania

ARTICLE INFO

Article history:
Received 19 February 2014
Received in revised form 27 June 2014
Accepted 4 July 2014
Available online 10 July 2014

Keywords:
Bogaz-like form
Karst corridor
Reverse fault
Strike-slip fault
Slickensides

ABSTRACT

Lenart and Pánek (2014) disagree with the term bogaz which we have attributed to the main structural discontinuities in the Vânturariţa-Buila Massif, Southern Carpathians. They also insist upon the mass movements as being the defining processes which generate them. Finally, the authors explain the genesis of fossil speleothems found in abundance on the exposed walls of the former crevice-type caves. We essentially followed within our study two aspects: similarities met by the studied tectonic-karst corridors and typical bogaz, as classically described in literature, and their connection with the basic structural and tectonic frame. The spatial context of the described landforms was not ignored, as we constantly mentioned the role of compressional forces in building a favorable environment for their occurrence (Tîrlă and Vijulie, 2013). Neotectonics and structural frame, particularly the strike-slip fault systems, are the major control factors in driving the evolution of the Vânturariţa-Buila Massif and the formation of the bogaz-like forms. Supplementary evidences for attesting reverse and strike-slip faulting were provided. Slope failures by gravitational collapse prevail, and rotational landslides are only isolated. The origin of discussed exposed speleothems was correctly explained in the comment, except that they were formed on fault walls, not on fractures of gravitational origin.

1. Why bogaz-like forms?

In the introduction of our published paper we have already demonstrated the significance of the term 'bogaz' according to the opinions exposed by various authors (Lauritzen, 2006; Ford and Williams, 2007; Goldie, 2009; Zseni, 2009). The term 'bogaz' is not assigned in an absolute sense, but descriptions vary quite broadly across regions, depending on genetic factors. Bogaz is not really synonymous with kluftkarren and grikes, which are smaller-scale features generated by solutional processes (Ford and Williams, 2007).

We consider the analyzed landforms bogaz-like, not typical bogaz. The starting point for this discourse was the general aspect of these landforms, as they were previously described in the Romanian literature (Ion, 1970). We stated in the very beginning of our paper that the primary role in their genesis is the structural frame, and not karstification. The abundance of joints, an intensively faulted bedrock and their relationship to the bogaz-like considered landforms, provided the basis of our study. Goldie (2009) also stated that "decay by mechanical processes of clear simple grikes" – and, we need to add in our case, typical bogaz – "is inevitable in well-fractured and well-bedded rocks". Furthermore, the trapezoidal morphology in section-shapes indicates a tectonic-karst corridor rather than a crevice.

There are no grabens in the studied area, and what Lenart and Pánek (2014) defined as such is merely a major ancient reverse fault enlarged by distension, mechanical and solutional processes. The term 'karst' should not be excluded from the essence of the landform-generating processes in a limestone massif.

The karst corridors cross lengthwise the ridge-top depressions on Mt. Piatra and Mt. Buila. This is delineated by uphill-facing scarps (sackung) to the south and fault-related scarps to the SW and NE. Gutiérrez-Santolalla et al. (2005), cited by Lenart and Pánek (2014), describes and analyzes several linear depressions in the Central Pyrenees which are more similar to these ridge-top depressions on Mounts Buila and Piatra, than to the tectonic-karst corridors we are discussing and which could hardly be called 'depressions'.

DOIs of original article: http://dx.doi.org/10.1016/j.geomorph.2014.07.003, http://dx.doi.org/10.1016/j.geomorph.2013.05.003.
* Corresponding author at: Bd. Nicolae Bălcescu Nr. 1, Sector 1, Postal code 010041 Bucharest, Romania. Tel.: +40 213 14 35 08, +40 724 693 615 (mobile); fax: +40 21 315 30 74.
E-mail address: tirla@geo.unibuc.ro (L. Tîrlă).

http://dx.doi.org/10.1016/j.geomorph.2014.07.003
0169-555X/

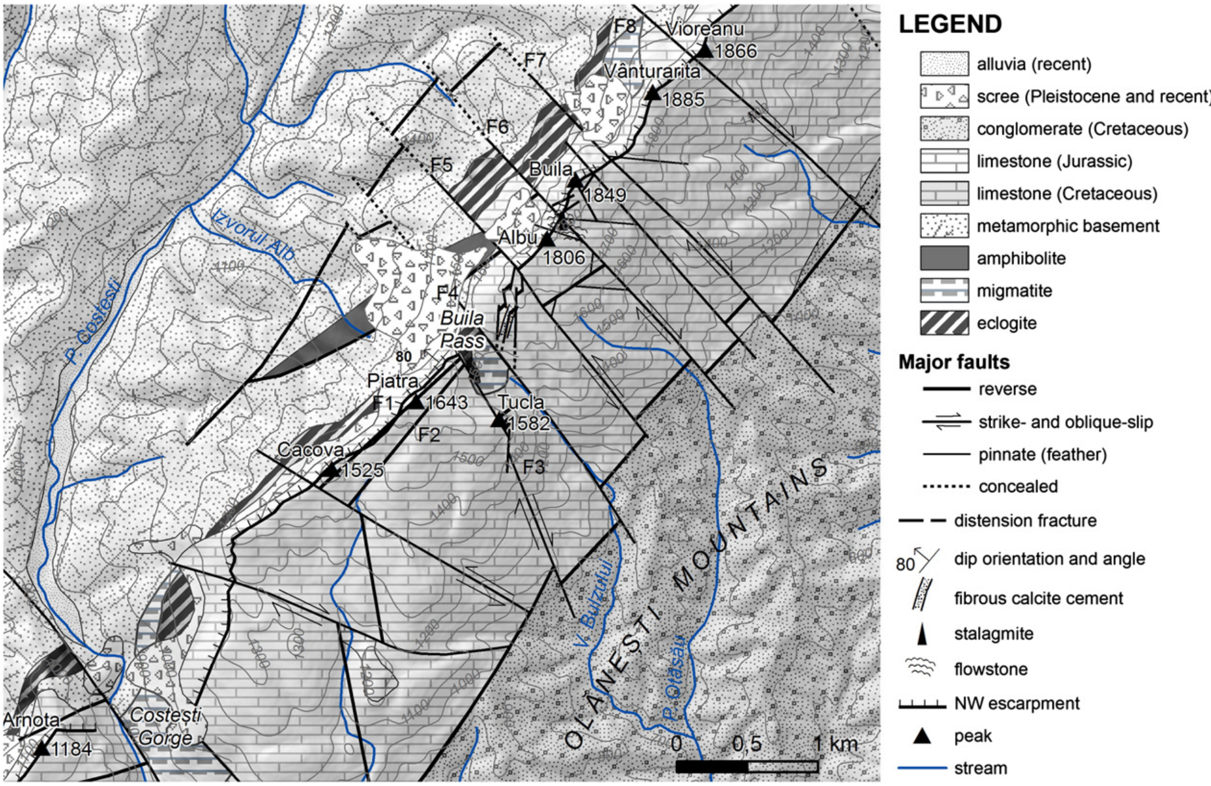

Fig. 1. Basic geology of the central area of the Vânturariţa-Buila Massif.

2. Fault systems as the major control agents in the genesis of the bogaz-like forms

2.1. Reverse faults

Lenart and Pánek (2014) insisted that the parallel alignments in Mt. Piatra and Mt. Albu (Vânturariţa-Buila Massif) are not faults, but gravitationally-induced fractures. We reject their hypothesis based on the following arguments:

- The field work evidenced that these are reverse faults (Fig. 2g–l). Thus, at the bottom of the corridor formed along F1, we identified slickensides and slickenlines caused by compression. The straightness and smoothness of the north-facing fault scarp on a large surface (tens of square meters) show without a doubt that it is a slickenside. This is also the displacement direction of the opposite (northern) compartment, which preserves numerous vertical slickenlines partly covered by calcite layers. One should consider the significant difference between the friction behaviors of limestone when comparing to other types of rocks (e.g. metamorphic). In time, limestone facets (including fault scarps) alter because of dissolution, and some evidence could readily be erased. On the contrary, others could be better preserved with calcite layers covering them. Both scarps are parallel and inclined at 78°–80° toward NW. This and the position of slickenlines indicate that it is a reverse fault, as an effect of compression. Further transversal dislocations might have locally triggered slow strike-slip movements. The scarp also preserves several slickenlines with the thicker end oriented toward the left (Fig. 2f);
- The presence of eclogite, migmatite and amphibolite bands within the metamorphic basement parallel to the limestone massif suggest ancient, deep compressive crustal movements most probably related to Laramian tectogenesis. They are also perpendicular to the general overthrust direction which ended with the emplacement of the Getic Unit.
- The general dip of the limestone bedrock is SE (Fig. 1). Distension and related failure of the SE-facing slope (e.g. in Mt. Ţucla) is practically irrelevant under this condition.
- A system of two parallel and straight corridors crossing Mt. Piatra lengthwise is represented in Fig. 2a, including the collapsed block reported by Lenart and Pánek (2014). The watershed runs straight between them, so if the origin of the fracture on the right (F1) could presumably be gravitational, this is physically impossible for the one on the left (F2). It is very probable that the singular block has slid by rotation, but the two parallel corridors located immediately south of it are of tectonic origin, i.e. — reverse fault zones, as we demonstrated above.
- A spatial correlation between the reverse faults on Mt. Piatra and the faults on Mt. Albu to the NE can be observed (Fig. 1). This belief was also shared by Ploaie (2005). The exposed walls are subject to mass movements and karstification (Fig. 2m).

Based on the widely shared opinions about the Carpathian tectogenesis, we consider that the longitudinal fault system parallel to the

Fig. 2. Geomorphic evidence of tectonic activity in the Vânturariţa-Buila Massif:a. Major fault systems on Mt. Piatra and Mt. Ţucla; b. the tectonic control of Mt. Ţucla outlined on a high resolution Google Earth image (retrieved 06/05/2014 from Digital Globe); c. two minor reverse faults in Mt. Ţucla, both parallel to the NNW escarpment and reverse faults on Mt. Piatra; d. the WSW strike-slip fault scarp and complementary karst valley on Mt. Ţucla; e. reverse and strike-slip faulting evidence on Mt. Piatra (at the narrow steep end of the bogaz-like form); f. slickenside on the NNW-facing fault wall and a slickenline pointing backward (toward the hammer), indicating the direction of displacement; g–h. certain slickensides at the bottom of Mt. Piatra; i. horizontal slickenlines attest the presence of a strike-slip fault; j–k. the fault zone F1 on Mt. Piatra; l. vertical slickenlines partly covered by calcite crusts on the SSE-facing wall of F1; m. a straight and smooth vertical fault plane (fault scarp of a bogaz-like form) on Mt. Albu; n. fibrous calcite cement grown on the same exposed fault wall; and o. the crust is made out of up to 7 calcite layers of various thicknesses (4 mm to 2 cm). Photos a–j and m–o by L. Tîrlă; photos k–l by M. Stoica.