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Geomorphological approach in karstic domain: importance of underground water in the Jura mountains.

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The Jura mountain belt is the north-westernmost and one of the most recent expressions of the Alpine orogeny (i.e. Mio-Pliocene times). The Jura has been well studied from a structural framework, but still remains the source of scientific debates, especially regarding its current and recent tectonic activity [Laubscher, 1992; Burkhard and Sommaruga, 1998]. It is deemed to be always in a shortening state, according to leveling data [Jouanne et al., 1998] and neotectonic observations [Madritsch et al., 2010]. However, the few GPS data available on the Jura do not show evidence of shortening, but rather a low-magnitude extension parallel to the arc [Walpersdorf et al., 2006]. Moreover, the traditionally accepted assumption of a collisional activity of the Jura raises the question of its geodynamic origin. The Western Alps are themselves in a post-collisional regime and characterized by a noticeable isostatic-related extension, due to the interaction between buoyancy forces and external dynamics [Sue et al., 2007].

Quantitative morphotectonic approaches have been increasingly used in active mountain belts to infer relationship between climates and tectonics in landscape evolution [Whipple, 2009]. In this study, we propose to apply morphometric tools to calcareous bedrock, in a slowly deformed mountain belt. In particular, we have used watersheds metrics determination and associated river profiles analysis to allow quantifying the degree and nature of the equilibrium between the tectonic forcing and the fluvial erosional agent [Kirby and Whipple, 2001]. Indeed, long-term river profiles evolution is controlled by climatic and tectonic forcing through the following expression [Whipple and Tucker, 1999]:

$$S = (U / K)^{1/n} A^{m/n}$$

(with U: uplift rate, K: empirical erodibility factor, function of hydrological and geological settings; A: drained area, m, n: empirical parameters).

We present here a systematic analysis of river profiles applied to the main drainage system of the Jura. The objective is to assess to what extent this powerful landscape analysis tool will be applicable to limestone bedrock settings where groundwater flow might be an important component of the hydrological system.

First results show that river slopes and knickpoints are poorly controlled by lithological variation within the Jura mountains. Quantitative analyses reveal abnormal longitudinal profiles, which are controlled by either tectonic and/or karstic processes. Evaluating the contribution of both tectonics and karst influence in the destabilization of river profiles is challenging and appears still unresolved. However these morphometrics signals seem to be in accordance with the presence of active N-S to NW-SE strike-slip faults, controlling both surface runoff and groundwater flow.