Modern faulting assessment from Messinian salinity crisis markers : the example of Toulaud Fault (Rhône-Alpes, France).

Jérémy Billant[a,b], Bellier Olivier[a], Franck Thomas[a], Philippe Dussouillez[a], Fabrice Hollender[c], Jean-Claude Hippolyte[a]
[a]Aix Marseille Univ, CNRS, IRD, Coll France, CEREGE, Aix-en-Provence, France.
[b]CUniversité Côte d'Azur, CNRS, Observatoire de la Côte d'Azur, IRD, Géoazur, Valbonne, France, [c]CEA,DEN

Introduction

The late hercynian Toulaud fault affects the basement and cuts through the Toulaud valley where the Rhône flowed and dug a deep canyon during the Messinian Salinity Crisis.

We study possible post-Messinian tectonic deformations along it using fault kinematics analysis, a high-resolution Digital Surface Model (DSM) generated using photogrammetry, morphological analysis as well as geophysical exploration (H/V method and Electrical Resistivity Tomography (ERT)).

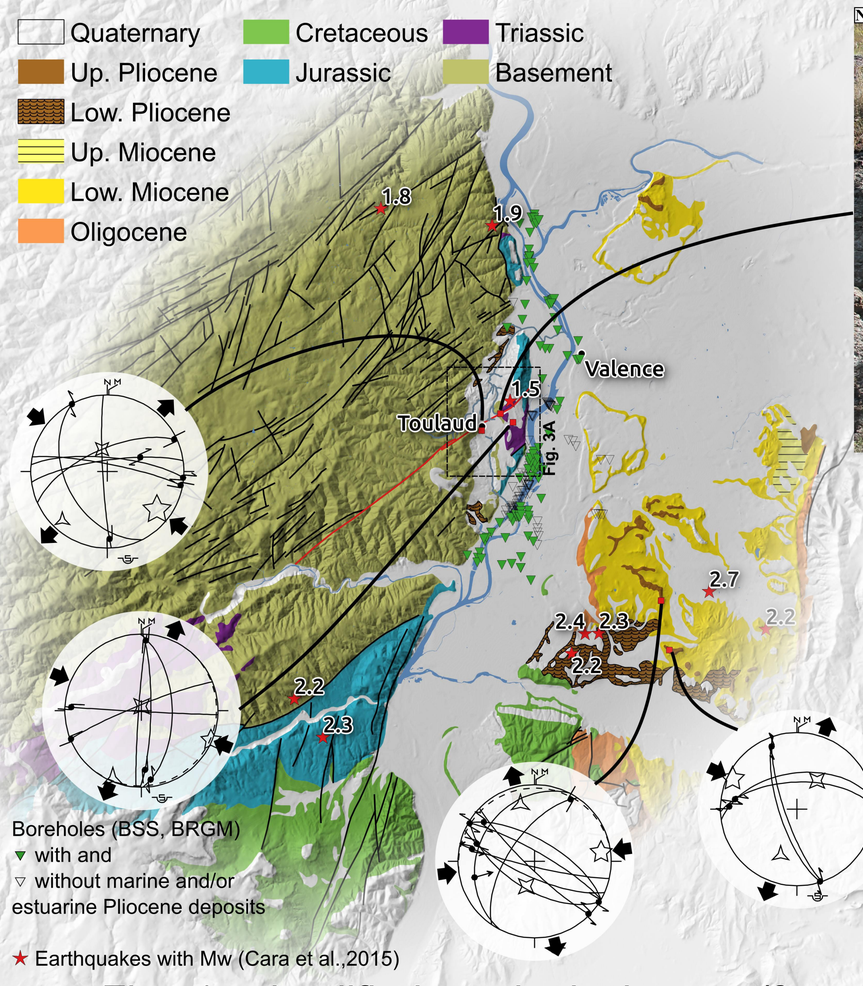

Fig. 1: simplified geological map (from Rouire et al. (1980)), boreholes, seismicity fault kinematics and stress states.

Fig. 2: Toulaud fault affecting basement, fault kinematics and stress state.

Fault kinematics

Inversion of striated fault planes measured in the basement, the Triassic sandstones and upper Pliocene conglomerates (Fig. 1) yields a strike-slip tectonic regime characterized by an E- to SE-trending σ1 axis consistent with a right-lateral kinematics along the Toulaud fault.

Morphological analysis

Analysis of the ~60cm resolution DSM (Fig. 3A) reveals apparent morphological right-lateral offset at two localities.

The first is ~50m long and shifts the cliff bordering the Rhône valley (Fig. 3B).

The second shifts of ~99m the eastern slope of the Toulaud valley (Fig. 3C).

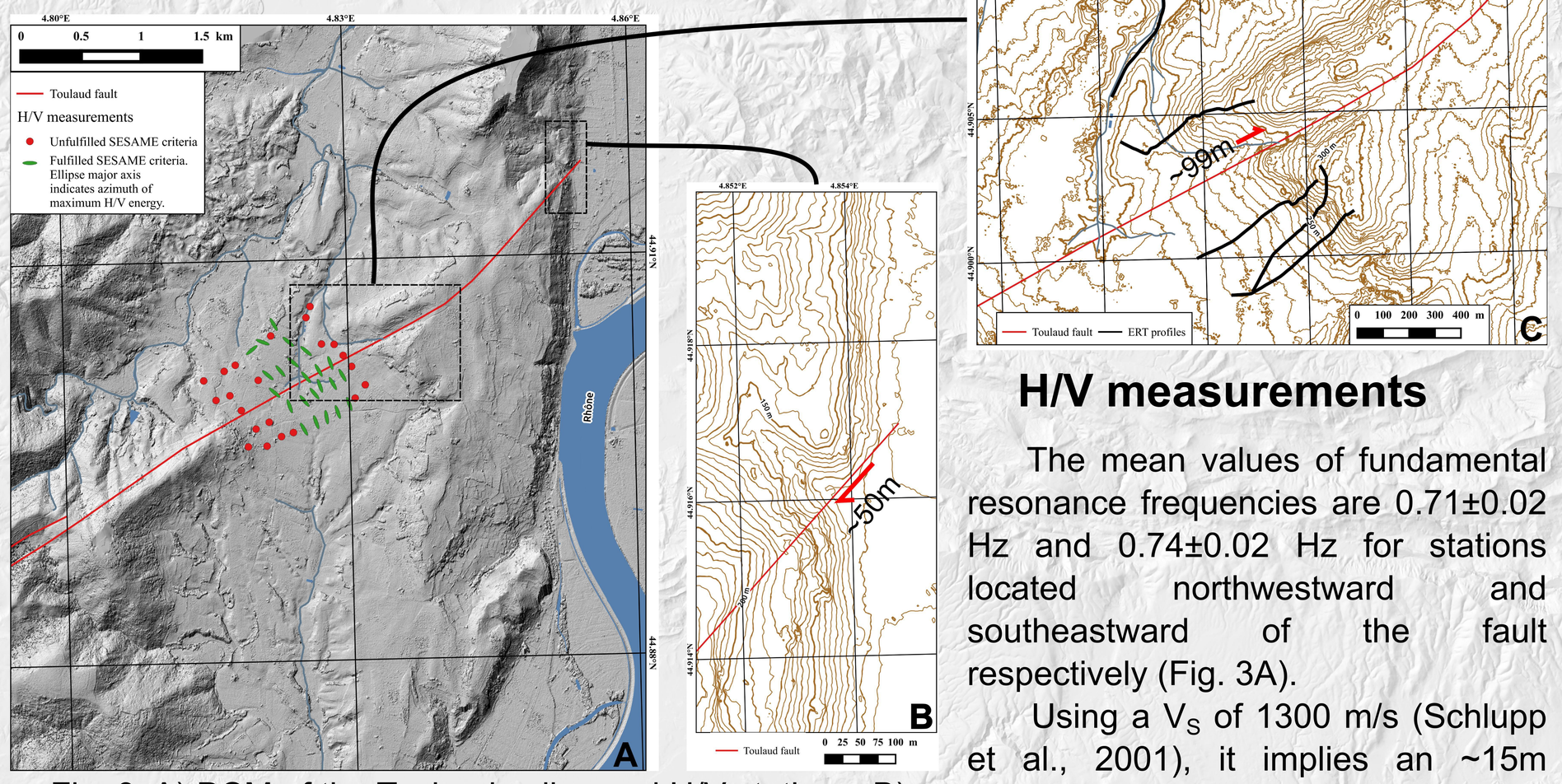

Fig. 3: A) DSM of the Toulaud valley and H/V stations. B) and C) zoom on apparent right-lateral morphological offsets.

H/V measurements

The mean values of fundamental resonance frequencies are 0.71±0.02 Hz and 0.74±0.02 Hz for stations located northwestward and southeastward of the fault respectively (Fig. 3A).

Using a V_S of 1300 m/s (Schlupp et al., 2001), it implies an ~15m relative uplift of the downstream block.

ERT analysis

ERT profils reveal two ranges of resistivity (Fig. 4), the former higher than 500 ohm.m that we attribute to the canyon flanck (basement) and the latter lower than 300 ohm.m that we attribute to the Plio-quaternary deposits.

The resistivity maps (Fig. 4) display a ~130m long left-lateral offset of the canyon flanck.

Fig. 4: Slices at different elevation of the 3D interpolation of the five ERT profils (location in Fig. 3C).

Conclusion

Because we can explain the observed apparent right-lateral offsets by structural inheritance or erosive process, we propose that the Toulaud fault slipped of ~130m left-laterally and ~15m vertically since 3.3 Ma, which implies a long term fault slip rate of ~0.04 mm/yr.