

Vertical deformation of the Ubaye valley (South East part of the French Alps) monitored by precise leveling

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The Ubaye valley (South East French Alps) is one of the most seismically active region of the massif (Saint-Paul-sur-Ubaye $M_I=5.5$ earthquake of 1959). Since at least 1977, several seismic crisis occurred. In 1989, 250 seismic events are reported. In 2003-2004, a seismic swarm generated 16000 micro-earthquakes East of the town of Barcelonnette. The observed migration of events suggested that overpressure of fluids was responsible for the activity (Jenatton et al., 2007; Daniel et al., 2011). A few kilometers to the North, in February 2012, a $M_I=4.5$ earthquake affected the region. This earthquake was followed by thousands of aftershocks which rate decreased very slowly in time. On April 7th 2014, an $M_I=5.2$ earthquake occurred (Thouvenot et al., 2016). Again it was followed by thousands of aftershocks; the present-day activity is still very high, much higher than a classic mainshock-aftershock sequence. Since, the seismic activity has never really decreased, being still very active in October 2016. As a matter of fact, the 2012-2016 seismic sequence shows a dual seismogenic behavior, including both sustained migrating seismic swarms ($M_I < 3$) and short-term mainshock-aftershocks sequences ($M_I > 4$).

To understand the seismic activity and its effects on surface deformation, we used precise leveling along a 30 km long-profile from the municipality of Barcelonnette (to the West) to the municipality of Meyronnes and Saint-Paul-sur-Ubaye (to the East). Several historical leveling sections were observed in 1909, 1949 and 1969 by the French Mapping Agency (IGN), and by research institutes in 2005, 2006 and 2014. We present the results of the comparison of the leveling over one century. We discuss its possible links to the regional seismic activity or to the local presence of unstable slopes.

We observe a change of tilting of the N-S section of Jausiers / Saint-Paul-sur-Ubaye (subsidence of 1 mm.yr^{-1} before 2005, and uplift of 3.5 mm.yr^{-1} after 2005), which may be linked to a change of stress regime in the valley as suggested by fluid pressures changes and its response in terms of seismic swarm activity. Moreover in the Meyronnes sector, we observe changes in displacement rates over the period 1909 – 1949 – 1969 – 2005 – 2014. These variations may be linked to unstable slopes in the village. The acceleration between 1949 and 1969 may be related to the $M_I=5.5$ earthquake of 1959. The deceleration after 2005 might be related to the mitigation works (surface drainage) installed in 2002.