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Unmasking the 1349 earthquake source (southern Italy): paleoseismological and archaeoseismological indications from the Aquae Iuliae fault

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ABSTRACT

The 9th September, 1349, earthquake was one of the most catastrophic events experienced along the Apennines. At least three main shocks struck a vast area of the Molise–Latium–Abruzzi regions, and damage was even sustained by the distant monumental buildings of Rome. The southern-most shock (Mw ~ 6.7) occurred at the border between southern Latium and western Molise, razing to the ground the towns of Isernia, Venafro and Cassino, amongst others, and devastating Montecassino Abbey. As with other Medieval catastrophic sequences (e.g., in December 1456, Mw ~ 6.5–7.0), this earthquake has not yet been associated to any seismogenic source; thus, it still represents a thorn in the flesh of earthquake geologists. We have here carried out a reappraisal of the effects of this earthquake, and through an interpretation of aerial photographs and a field survey, we have carried out paleoseismological analyses across a poorly known, ~N130 normal fault that crosses the Molise–Campania border. This structure showed repeated surface ruptures during the late Holocene, the last one of which fits excellently with the 1349 event, both in terms of the dating and the rupture dimension. On the other hand, archaeoseismic analyses have also indicated the faulting of an Augustean aqueduct. The amount of apparent offset of the aqueduct across the fault traces shows that there were other surface faulting event(s) during the Roman–High Middle-Age period. Therefore, in trying to ascertain whether these events were associated with known (potentially of 346 AD or 848 AD), or unknown earthquakes in the area, it became possible that this ~20-km-long fault (here named the Aquae Iuliae fault) is characterized by high slip rates and a short recurrence time. This is in agreement with both the similar behaviour of the neighbouring northern Matese fault system, and with recent GPS analyses showing unexpectedly high extension rates in this area.

1. Introduction

There are many geodynamic secrets hidden amongst the folds of the Apennine chain, and the answers to many questions concerning its seismogenesis remain within its faults. From northern Tuscany to Calabria, the Italian Peninsula has been struck at least sixty times by Mw ≥ 6.0 earthquakes in the past two millennia, half of which were with Mw > 6.5. Although almost all of these earthquakes originated within the upper crust (i.e., from ~15 km in depth) because of the extensional processes currently ongoing along the chain (i.e., $\sigma 3$ ~ perpendicular to the axis), only a few causative faults have been identified to date. In the 1990's, through the awareness that in Italy surface faulting was also a likely occurrence (e.g., in the 1980 Mw 6.9 Irpinia earthquake; Fig. 1), earthquake geology received a large impulse, and several studies on active tectonics and paleoseismology were published. However, whereas our seismotectonics knowledge is today well documented in the Umbria–Abruzzi chain (central Apennines), we still know very little about the seismogenic faults of the northern and southern Apennines. This knowledge gap has a logical explanation for the northern sector, where current strain rates and earthquake magnitudes are lower than for the rest of the Apennine chain; in other words, seismogenic faults are generally below the lower boundary of surface visibility (Mw < 6.5), and thus earthquake geologists have difficulties in the search for their geomorphological signatures. Instead, the southern Apennines are characterized by the strongest and most frequent earthquakes of the chain, while almost all of their causative faults remain unknown. This is also true for the Mw ~ 7 earthquakes, such as those which occurred in Irpinia (1694), Sannio (1688), Basilicata (1857), and for the Medieval seismic sequences of 1349 and 1456 (Fig. 1). Apart from suggestive seismogenic hypotheses derived from geophysical prospecting or from inversion of the

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