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Fluid flow and faulting history of the Iano tectonic window (Southern Tuscany, Italy).

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In the Iano area (Southern Tuscany) a small tectonic window of Tuscan metamorphic units is observed. This belongs to the northernmost part of the so-called Mid-Tuscan ridge and, during Pliocene, formed a submarine high, now defining the easternmost shoulder of the Volterra Pliocene basin. The area gives the opportunity to investigate the complete cycle of negative inversion from crustal thickening to crustal thinning, which characterizes Southern Tuscany. Our new data focus on the western margin of the Iano ridge, and in particular on a system of high angle normal faults that represents the youngest structures of the investigated area. These structures, deformed low angle regional detachments locally juxtaposing the uppermost units of contractional nappe stack (the ophiolite-bearing Ligurian units), with the Tuscan metamorphic units, with an almost complete excision of at least 3.5 Km thick Mesozoic to Tertiary Tuscan nappe succession. The high angle normal faults show variable Plio-Quaternary vertical displacements from few meters to about 500 meters, and acted as pathways for the upwelling of hydrothermal fluids, as revealed by Pleistocene travertine deposits, hydrothermal alteration and occurrence of different generations of fluid inclusions in hydrothermal veins associated with these fault systems. Fluid inclusions were studied in quartz veins hosted in the Verrucano metasediments forming the top of the Tuscan metamorphic unit, as well as in some carbonate lithotypes (Cretaceous to Tertiary in age) of the overlying Tuscan Nappe. Two different kinds of fluid inclusions were documented. The Type 1 are multiphase (liquid + vapor + 1 daughter mineral) liquid-rich fluid inclusions whereas the Type 2 are two-phase (liquid + vapor) liquid-rich fluid inclusions. Type 1 fluid inclusions are primary in origin and were found only in quartz veins present in Verrucano metarudites, whereas Type 2 fluid inclusions occur in quartz veins present in both Verrucano phyllites and quartzites and in the carbonate units of the Tuscan Nappe. These are secondary and can be furthermore distinguished in two sub-populations (Type 2a and Type 2b) on the basis of petrographic observation and microthermometric data. Fluid inclusion investigation evidenced an evolution of the hydrothermal fluids from relatively high-T (~265°C) and hypersaline (35 wt.% $NaCl_{equiv.}$) fluids trapped at about 100 MPa, to lower temperature (~195°C) and salinity (~9.5 wt.% $NaCl_{equiv.}$) fluids, having circulated in the high-angle fault system. Based on the new data and a revision of the local tectonic setting a fluid-rock interaction history has been reconstructed with new hints and constraints for the Plio-Quaternary extensional history of the Volterra basin.