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Re-discussing the diffused brecciation in the Messinian sediments of the Mediterranean Sea as the product of a past methane seep

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Brecciation extensively affects the carbonatic units developed during the Mediterranean Salinity Crisis (Upper Messinian), which can be roughly divided into two major phases (evaporitic and post-evaporitic). To date, these units have been commonly interpreted as evaporitic collapse breccias, eventually related to karst systems (Pedley & Grasso, 1993) and, recently, as the product of mass wasting processes (Roveri et al., 2008).

Nevertheless, a research addressed to the characterization of the mechanism triggering brecciation, including particle size distribution analysis and fractal analysis, are still required. In order to provide ground-data for this kind of investigation, in the present study the Messinian breccias from Rossano Basin (north-eastern Calabria, southern Italy) and from Maiella Mountains (Abruzzo, Central Italy), have been analyzed through an interdisciplinary approach. Sedimentological and mesofabric observations have been integrated with meso-to-micro and SEM facies analyses, along with natural radioactivity, compositional and stable isotopes data.

Breccias are made up of limestones exhibiting high variations in facies and thickness. In the Rossano section the studied unit (*Calcare di Base Fm.*) crops out as an alternation of thick-bedded massive carbonate and pelites, conformably overlaying the pre-evaporitic unit (*Tripoli Fm.*). In contrast, in the Maiella area brecciated limestones unconformably overlay the evaporitic unit (*Gessoso-Solfifera Fm.*) and show higher lateral variability: their geometry varies from a patchy distribution within barren and laminated pelites (host sediment), to thick-bedded carbonate bodies.

Breccias are predominantly monomictic, clast-supported and devoid of gravity segregation. Their clasts, mainly subdecimetric in size, exhibit no preferential distribution. Sin-to-post brecciation veining often occurs. As a whole the brecciated units are constituted by a peloidal mudstone showing chaotic fabric, since breccias are associated with non-brecciated portions, carbonate concretions, discontinous laminae and secondary calcitic nodules, interrupting one another. Traces of bitumen and organic matter also occur.

Interestingly, thin sections and SEM observations revealed that even non-brecciated portions and pelites show microbrecciated areas. The complex framework of microfacies is further complicated by different stages of cementation revealed by the occurrence of microsparite, drusy mosaic calcite and isopachous cement. The whole rock shows an intense natural radioactivity (20÷63 Cps), entirely related to authigenic 238U. In the Maiella section the limestones, exhibiting framboidal pyrite and barite, are 13C depleted, with δ13C values mid-spanning from -15 to -27 ‰ PDB.

The integrated facies analysis revealed that brecciation of Messinian limestones occurred in situ. Nonetheless, the autobreccia is not even the result of an evaporitic collapse, given the preservation of the primary bedding and the lack of any evidence to suggest a control of gravity. The acquired data instead indicate that Messinian limestones are intraformational breccias, possibly related to hydraulic fracturing. The contextual formation of authigenic phases and the isotopic data converge to depict a fossil cold seep environment, where overpressure of methane could trigger brecciation. The presence of methane is reasonable, since Messinian Salinity Crisis came up at the end of one million year of basin-scale accumulation of organic matter under anoxic conditions. The interpretation given here has already been suggested by Ryan (2009) as a hypothesis to investigate further.

Analyzing the mechanism triggering brecciation in outcropping carbonates, could provide a unique tool for understanding the processes occurring in the subsurface of present methane seeps.

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