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Relating facies and rheological properties of rocksalt: new insights from physical properties and microstructural observations on Messinian halite of Italian Peninsula.

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The importance and economic interest on rocksalt deposits and salt bodies are well known and extensively studied. However, previous scientific works have mainly focused on synthetic rocksalt or commercial salt, whereas the role of natural heterogeneities and their effect on salt rheology have been not investigated quantitatively.
Here we present a comprehensive salt facies study including salt samples from Volterra Basin, northern Italy, Caltanissetta Basin, Sicily and Crotone Basin, southern Italy.
Throughout optical and images analyses on thin sections we identified four salt facies, that have been named as “green”, “blue”, “black” and “red” depending on the relationships between primary and secondary salt, recrystallization and deformation. The “green” facies has a great abundance in primary salt remnants (around 20% in volume) rich in primary fluid inclusions and rather rounded crystals (average roundness is 0,6) with no preferred orientation. Thus is considered the less deformed and recrystallized end member. Proceeding toward increasing salt deformation, primary salt remnants are gradually dissolved. Secondary salt is formed and a progressive decrease in average crystals size, increase in crystals elongation and preferred orientation can be observed. So, we identified the “black” facies, with much less primary salt remnants (around 10% in volume), more elongated (average roundness is 0,4) and smaller (average area 1,6 mm2) crystals showing a clear preferred orientation. Then, the “red” facies has been analyzed, being the most deformed salt end member, with almost no primary salt remnants and even smaller (average crystals area is 0,5mm2), very elongated crystals (average roundness is 0,4) also with a neat preferred orientation. The “blue” facies cannot be placed on this evolutionary path, being made up of totally recrystallized but only very slightly deformed (roundness is 0,6) and bigger (average area is 4,9 mm2) crystals with no preferred orientation.
Seismic waves velocity measurements and uniaxial compressive runs allowed to test the effect exerted by facies characteristics on the physical and mechanical properties of salt. Average seismic waves velocity resulted faster and less variable in deformed and recrystallized salt (“black” and “red” facies) compared to the “green” facies. Dynamic Young’s Modulus mirrors this behavior, with lowest values related to the primary salt rich facies. Static Young’s Moduli (Es) result much lower than the dynamic ones. In this case lowest values are related to the highly deformed and recrystallized “red” facies. The peak stress resulted inversely proportional to the static Young’s Moduli, regardless of the salt facies. Volumetric deformation was higher for the primary salt rich facies.
Therefore, we found that parameters like crystals elongation, average crystals area, primary salt abundance and average crystals orientation may influence, for instance, resulting Vp, Es and peak stress. Namely, we observed that with increasing deformation, also recrystallization degree and crystals elongation increase, while primary crystals abundance, Es and average crystals dimension decrease.