Diagenesis and controls on reservoir quality of Lower Triassic red beds (Buntsandstein) from a marginal basin facies, SW Germany

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With regard to climate change and the energy transition, the red beds of the Buntsandstein from the Central European Basin have come into focus. While in previous decades the focus was on the Buntsandstein from the basin center due to the discovery of several gas fields, the Buntsandstein from the southern basin margin may serve as a potential lithology for geothermal applications and lithium brine extractions. Based on three drill cores from SW Germany covering the Lower, Middle, and Upper Buntsandstein, we present porosity and permeability data combined with petrographic data (point counting) in order to better understand reservoir quality and the diagenetic history of the Buntsandstein from the southern basin margin. The sandstones reveal textural and mineralogical characteristics that indicate deposition in eolian and fluvial settings. Porosities range from 7.9 to 21.5 % and permeabilities vary over six orders of magnitude from 0.001 to 515 mD. Coarser detrital quartz-rich eolian sandstones tend to have better reservoir qualities than finer fluvial sandstones, which are rich in authigenic illite. The major influence on reservoir quality are large grain sizes ≥0.31 mm. Authigenic cements such as illite (pore-lining and pore-filling) and syntaxial quartz overgrowths interact with each other and each exert a local influence on reservoir quality. The presence of consistent illite coatings on detrital quartz efficiently impeded syntaxial quartz overgrowth. In contrast, the lack of consistent illite coatings on detrital quartz locally resulted in syntaxial quartz overgrowths that stabilized the granular framework and, thus, preserved primary porosity. The comparison of the results of this and other studies on the central and marginal Buntsandstein indicates that its reservoir quality varies over small and large scales and within the same stratigraphic levels. Reservoir quality is mainly controlled by large grain sizes but further local controls such as authigenic illite and syntaxial quartz overgrowths exist as well.