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Comparison of aquifer characteristics of Paleozoic Permosilesian and Mesozoic Buntsandstein clastic rocks in the Thuringian Basin, Central Germany

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The Thuringian Basin in Central Germany is a structural trough with Buntsandstein and Zechstein outcropping at the margins and Keuper sedimentary fill in the center. Major aquifer units are Permosilesian, Lower and Middle Buntsandstein and Keuper clastics. In this study we compare aquifer characteristics of the Permosilesian and Buntsandstein sediments. Petrophysical, facial/textural, compositional/diagenetic and chemical properties were studied in order to investigate fluid flow properties in the present and past.

The analyzed Buntsandstein sediments occur in present depths between approx. 400-900 m. Paleoburial depths were in the order of 2800 m. The succession is dominated by sandstones and mudstones. Deposition took place in lacustrine to fluvial (Lower Buntsandstein) and fluvial to eolian settings (Middle Buntsandstein). In order to compare sediments of almost identical origin, only the fluvial-alluvial sandstones were considered in this contribution. The sandstones are poorly to well sorted arkoses to subarkoses consisting of quartz, major amounts of feldspar and only negligible amounts of lithoclasts (volcanic, sedimentary rocks). Diagenetic features are early ferrous clay coatings, authigenic quartz overgrowth, feldspar alteration (including leaching, illitisation), blocky sulfate and carbonate cementation and late cement dissolution, formation of illite (early tangential illites, radial illite rims, late meshwork illites) and locally kaolinite.

The analyzed Permosilesian sediments occur in present depths of about 1500-2500 m. They comprise conglomerates, sandstones and mudstones of fluvial-alluvial origin. Sandstones are moderately sorted sublitharenites and litharenites consisting of quartz, minor amounts of feldspar and a significant content of metamorphic and subordinately volcanic rock fragments. Major diagenetic features are early ferrous clay coatings and matrix, some authigenic quartz cement, feldspar and lithoclast alteration (including leaching, illitisation), minor blocky carbonate cements and intense illite formation (tangential illites, meshwork illites). Bulk geochemical analyzes (methods: ICP-MS/OES, XRF) reveal no significant differences in major element contents. However, compared to Buntsandstein sandstones the Permosilesian sediments are enriched in all transition metals caused by higher amounts of volcanic and metamorphic lithoclasts, and clay matrix respectively.

Comparison of petrophysical characteristics reveals low porosity and permeabilities in the Permosilesian sediments (φ = up to 10 %, K = 0,01 - 1 mD), and higher ones in the Buntsandstein samples (φ = up to 24 %, K =0,01 - >100 mD). These differences are attributed to (1) facial differences (texture, matrix content), (2) compositional differences (alteration and dissolution of detrital grains), (3) differences in the diagenetic history (e.g. fabric stabilization by early blocky cements, cement dissolution, intense clay mineral formation in primary and secondary pore space), and (4) differences in burial depth (degree of mechanical compaction).

We intent to characterize described influences on aquifer properties and the resulting fluid flow properties in order to understand fluid migration in sedimentary basins in the present and past.