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Deep geothermal potential in an orogenic wedge: examples from western Austria

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In Austria, deep geothermal energy is currently exploited in the Alpine foreland of Upper Austria and in the Styrian basin, whilst the Vienna basin is known as an area with high potential (Goldbrunner 2010). In both cases the geological setting is already well understood. The targets of deep geothermal drillings in the foreland are aquifers within the autochthonous sedimentary cover of the European basement buried below Alpine Foreland deposits. The Upper Jurassic limestone is especially well suited due to its karstification and high primary porosity, particularly when it occurs in reef facies. Towards the south and into the main body of the Alps complications arise due to facies changes and the tectonic overprint; therefore a detailed study at each potential site is required. In the following, three different geological settings in western Austria and their deep geothermal potential are discussed.

In the Alpine foreland of westernmost Austria, near Lake Constance, the autochthonous Mesozoic sediments are situated in an attainable depth of 4 to 4.5 km below the ground surface. As the limestone occurs in a distal facies and no intense karstification is known (Jodocy et al. 2009), the best prospects for a considerable permeability are expected in the damage zone of major fault structures. To establish a deep hydrothermal system it will be necessary to hit the damage zone with both the production and the injection well. Near Bregenz a promising structure has been detected in seismic sections. The most promising approach for further characterization of the damage zone is 3D seismics, as has been recently shown by the nearby project run by the city of St. Gallen.

According to seismic data in southern Vorarlberg, the base of the Helvetic nappe stack is located at $\sim$4.5 km below the ground surface. Within the Helvetic nappes, several formations have a high hydrothermal potential, especially when fractured due to folding or faulting; however only Jurassic parts of the lower nappe are probably present in a depth useful for a deep hydrothermal system. The Cretaceous Helvetic units are characterised by folding while the thicker Jurassic Quintener limestone is additionally stacked on thrust faults and occurs in the form of isolated blocks embedded in more incompetent clay-rich basin deposits. To utilize a deep aquifer in this setting it will be necessary to hit the same limestone block with both the production and the injection well.

The dolomites and limestones of the Northern Calcareous Alps form a promising hydrothermal reservoir due to their high permeability related to intense fracturing. As known from the well "Vorderriss 1", the geothermal gradient is quite low in the Northern Calcareous Alps ($\sim$2.3°C / 100 m; Bachmann et al. 1981), therefore hot water with 100°C will only be found at 4 – 4.5 km depth. According to the geological interpretation of the Transalp-seismic section (Ortner et al. 2006), Mesozoic limestones of the Northern Calcareous Alps are present below the Inn valley to a depth of $\sim$6.5 km below the ground surface, however their internal structure and lateral extension are difficult to predict.

Although some potentially good settings for geothermal exploitation are present in western Austria all locations require an individual geological analysis followed by a high resolution (3D) seismic exploration for exact planning and the reduction of risks.

References

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