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Depth imaging Helicopter-borne TEM of the Silurian carbonate succession on the island of Gotland, Sweden – impact on assessment of stratigraphy, groundwater resources and limestone quality.

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The island of Gotland is located in the south Baltic Sea and is a popular touristic site. During the summer this results in a strained situation on the groundwater resources as most of these are located in the bedrock with limited storage capacity. The 3 184 km^2 large island endures hence, as many other islands great problems regarding the groundwater resources. Saline groundwater and limited capacities of the aquifers are the most severe problems to mitigate for the island community. The stratigraphy and lithology of the Silurian carbonate dominated bedrock surface is well constrained. The carbonate succession of reefal limestone (boundstone), grainstone and marlstone was primarily formed in an inner carbonate shelf setting with frequent lateral and vertical shift in lithology. The subsurface distribution of these various lithofacies, with different prerequisites regarding groundwater quantity and quality, has until now been largely unknown. The quest for finding new aquifers and mapping the saline groundwater level has rendered an extensive campaign with geophysical and geological investigations of the bedrock, primarily using Helicopter-borne transient electromagnetic measurements (SkyTEM) combined with ground measurements using Radio-Magnetic Telluric measurements (RMT) and borehole wire-line logging. During two campaigns in 2013 and 2015 totally 1 100 km^2 of the island was mapped using the SkyTEM technique. The investigations have proven to greatly improve the understanding of the subsurface as it gives a unique high resolution image on the carbonate bedrock succession down to several hundred meters depth. This has for the first time allowed the construction of a 3D stratigraphical as well as lithological model of the subsurface geology. The detailed imaging has also made it possible to identify several new potential aquifers and at what depth saline groundwater is encountered. The resistivity signatures of the bedrock have also allowed for a distinction between non argillaceous reefal limestone, argillaceous limestone and marlstone, which have relevance to the evaluation of the lime and aggregate resources on the island. The results are illustrated by a number of interpreted TEM profiles and 3D models on various stratigraphical and lithological cases across the Island of Gotland. The results have also contributed significantly to the geoscientific understanding of the sequence stratigraphic evolution of the Silurian succession on Gotland.