

## **Upscaling of Triaxial Resistivity Data Measured on the Norwegian Continental Shelf and Observations Relevant for CSEM Imaging**

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### **ABSTRACT**

We have compiled publically available resistivity data measured by triaxial induction (triax) devices on the Norwegian continental shelf. The main purpose is to determine the formation anisotropy on a scale relevant for controlled source electro magnetic (CSEM) imaging. The compilation is based on logs from 17 different wells providing data for 32 different formations. A vertical resistivity,  $R_v$ , was computed by upscaling vertical resistivity data from the triax log and using a series resistor coupling analogue. Similarly, a horizontal resistivity,  $R_h$ , was computed by upscaling horizontal resistivity data using a parallel resistor coupling, and the formation anisotropy was computed as the ratio  $\lambda = R_v/R_h$ . In both cases, the resistivity was upscaled to the formation thickness. The results show that very few (< 5 %) formations were isotropic or nearly isotropic (with  $\lambda < 1.4$ ). The median of the upscaled anisotropy of all formations was found to be 2.5. In contrast, when such data is not available and upscaling conventional (deep induction or deep laterolog) resistivity in a similar manner, most formations (> 70 %) were found to be nearly isotropic, and the median value was 1.1 in this case. CSEM data was computed assuming two resistivity models, the first based on the triax resistivity and the second based on the conventional resistivity. A comparison of these data sets show that the effect of anisotropy on the data can be significant compared to the response of a HC-filled reservoir. This observation suggests that formation anisotropy should not be ignored when evaluating CSEM results. Commonly, the vertical resistivity or anisotropy as mapped by CSEM, is used as direct HC-indicator. A few examples are presented where these indicators may break down when lacking information about the formation anisotropy, leading to potentially a false-positive or -negative interpretations. These observations support that formation anisotropy is very important in CSEM-imaging.