Resistivity

The resistivity of the hydrated sediments, R_t can be calculated using the Archie's law (Nobes et al., 1986) as

$$S_w{}^n = \frac{R_0}{R_t} \tag{12}$$

where , n and are respectively the water saturation, saturation exponent and the background resistivity i.e. the resistivity of the formation when sediment pores are filled only with water. The background resistivity, R_0 is calculated as

$$R_0 = \frac{aR_w}{\phi^m} \tag{13}$$

where ϕ, , m and a are the porosity, water resistivity, cementation factor and a constant respectively. The Archie's parameters are taken as =0.9, =2.7 and =1.9 (Collet, 2000). The is calculated using the relation of Nobes et al (1986) as

$$R_w = 1/(3+\frac{T}{10}) \tag{14}$$

where T is the formation temperature that can be calculated at different depths using the derived geothermal gradient and the seafloor temperature. The variation of background resistivity with depth and the associated error bounds are shown in Figure 8. The resistivity of the hydrated sediment is also shown in Figure 8. The study shows that the background resistivity at BSR varies from 1.90 to 3.0 Ù-m. Whereas presence of gas-hydrates increases the formation resistivity and the value at BSR varies between 2.4 and 4.0 Ù-m. This indicates that the seafloor electrical resistivity profiling can be used for the identification and quantification of gas-hydrates, particularly at regions where BSR is not detected on seismic section but gas-hydrates are found while drilling.

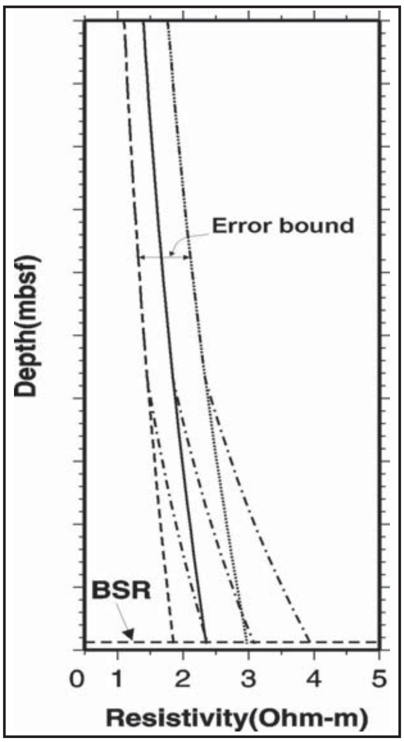

Fig. 8. Background resistivity versus depth function along with the lower- and upper-bounds. The resistivity variation of hydrated sediment is also shown.

Conclusions

A case study is presented here to demonstrate how we can estimate the saturation of gas-hydrates and determine various other physical parameters like porosity, density, thermal conductivity, geothermal gradient, heat flow, resistivity of sedimentary formation using BSR on seismic data. Since, there are many existing relations between velocity, porosity and saturation, use of a particular equation may be associated with some errors in calculating the parameters. As we use the velocity-depth function derived by the sophisticated waveform inversion, the velocity function can be considered quite accurate. Presuming ±5% error in velocity model, we show the error bounds of various physical parameters including the saturation of gas-hydrates. The study shows that presence of gas-hydrates decreases the thermal conductivity and increases the resistivity of the formation with respect to the background trend. We see a good agreement between the BSR-derived heat flow and the estimated heat flow available near the study area. Knowledge of heat flow helps to understand issues related to prevailing fluid expulsion process, heat transport mechanism, sediment thickening, evolution of continental margins etc. The low heat flow observed in the study may be due to tectonic thickening in the accretionary prism caused by high rate of sedimentation. This seems to be a very good approach in determining various physical parameters without any probe data, particularly in inaccessible areas. It is to be stated that the derivation of these parameters suffers from propagation errors.

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