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The Faroe Islands geological stripping using weak assumptions

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In a complex geological-/geophysical setup with a general source distribution, the result of the source modeling from the gravity data depends on how the available independent information is being used. The model construction is implicitly hierarchic in a sense that, ultimately, the final inversion for the unknown sources (us) is done from the residual gravity signal Δg_{us}. In order to make a successful inversion (so that the unknown source model is a good approximation to the existing true source distribution) the precondition must be that Δg_{us} is modeled correctly from the measured gravity signal Δg and using the independent information about the subsurface. Implicitly, the gravity attraction Δg_{ks} from the known sources (ks) must be modeled correctly so that:

$$\Delta g_{us} = \Delta g - \Delta g_{ks}$$

yields as good as possible Δg_{us}; *a geological stripping*. In short, the hierarchy in model construction implies that any error in Δg_{ks} generates an error in $\Delta g_{us.}$ Consequently, a lot of effort should be put into the correct modeling of Δg_{ks}.

One pitfall of the geological stripping is that the wrong use of either the mathematical assumptions or the independent information only in very severe cases can be contradicted by Δg_{us}. However, the fact that Δg_{us} does not contradict Δg_{ks} is not synonymous to that Δg_{ks} (and thereby Δg_{us}) is correctly modeled.

In our quest to do the "objective geological stripping" we advocate a cautious method in modeling Δg_{ks} for a large marine area with complex geology around The Faroe Islands. One such technique is to use the independent knowledge of bathymetry to "strip off" the gravitational effect of the sea water without any assumption about the mass density contrast to the sea bottom (that could bias Δg_{ks}). Another technique is to use in combination both the gravity anomalies and the horizontal gradients, i.e. a transformation of Δg and Δg_{ks}. A consequence of Green's third identity of potential theorem is that a unique solution cannot be obtained by simply transforming the external field. However, we can safely assume that the two types of signals (the gravity anomalies and the horizontal gradients) are generated by the same source distribution. Although a unique model of the subsurface cannot be obtained, we can utilize that the weighting between the contributions from the shallow/known sources and the deep/unknown sources is different in these two types of the gravity data. Knowing independently, e.g. from seismograms, the approximate depth to the "unknown sources" bears a possibility to get a good model of Δg_{us} even whenΔg_{ks}andΔg_{us} are correlated.