A 3D Magnetic Property Model of the Cook Inlet Basin, South-Central Alaska -- Imaging Tertiary Structural Traps and Mesozoic Sedimentary Thickness

Phillips, Jeffrey D.[*1]; Stanley, Richard G.[2]
(1) USGS, Denver, CO.
(2) USGS, Menlo Park, CA.

The Cook Inlet basin of south-central Alaska is the principal source of natural gas used for heating and electric power generation in the Anchorage metropolitan area. Oil is also produced in the basin. In preparation for a new oil and gas resource assessment of the Cook Inlet basin, the U.S. Geological Survey has reanalyzed commercially available, medium- to high-resolution aeromagnetic data over the basin using separation filtering and experimental inversion software.

The filtering was used to separate the magnetic field produced within the Tertiary sedimentary section of the basin from the field produced by the older sedimentary and basement rocks. Nearly all of the oil and gas in Cook Inlet is produced from structural traps within the Tertiary sedimentary section. Due to contrasts in the magnetic properties of the folded and faulted sedimentary beds, these structures are imaged quite well as short-wavelength aeromagnetic anomalies. The deeper Mesozoic sedimentary section contains some potential hydrocarbon reservoir rocks as well as the principal oil source rocks. The thickness of the Mesozoic sedimentary rocks is poorly known; only 5 wells penetrate both the top and bottom of this section. Separation filtering of the aeromagnetic data was facilitated by the recent publication of a Tertiary sedimentary thickness map based on interpretation of drillhole data and seismic reflection profiles by the State of Alaska.

The Mesozoic sedimentary section is underlain by a thick section of strongly magnetic volcanic and volcaniclastic rocks of the Talkeetna formation. A linear magnetic high that follows much of the eastern side of the Cook Inlet basin is likely produced by steeply-dipping, normally magnetized Talkeetna. Data from 27 drillholes indicate that Talkeetna is present directly beneath the sedimentary section on both the eastern and western sides of the basin. Negative aeromagnetic anomalies suggest that much of this buried Talkeetna is characterized by reversed remanent magnetization. The interface between the non-magnetic or weakly magnetic Mesozoic sedimentary rocks and the underlying, strongly magnetic Talkeetna was the primary target of the magnetic inversion, which used experimental software developed by the Geological Survey of Canada.

Because a full 3D inversion of the aeromagnetic data was impractical, 2D inversions were performed along the individual rows and columns of the filtered aeromagnetic data grid. 2D inversions assume that magnetic structures strike perpendicular to the plane of the section; if they do not, the source depths are overestimated. The 2D solutions for the rows and the columns were merged into a combined 3D solution by choosing the magnetization at each location that had the maximum magnitude. This solution tended to compensate for overestimated source

depths by minimizing the thickness of the sedimentary section, thus providing reasonable thickness estimates for the Mesozoic sedimentary section.