Open-File Report 01-0476, Supplementary Text

Basement Geophysical Interpretation of the National Petroleum Reserve Alaska (NPRA), Northern Alaska – supplementary text

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Open-File Report 01-0476
2001

TEXT TO ACCOMPANY BOXES ON POSTER PANEL 1 – Part I, Overview

Project flowchart

This box contains a pictorial representation of geophysical modeling and interpretation done for this project. The colored rectangles represent things: data and maps. The pink ovals represent processes: modeling and interpretation. The rectangles are color coded by data type: seismic information is orange, borehole data is yellow, gravity is light green, magnetics is magenta, and topography is blue-green. The first column depicts the three-dimensional gravity modeling described in more detail on poster panel 2. The second column depicts the three-dimensional magnetic interpretation that is described on poster panel 3. The third column depicts the construction of the basement thickness map on poster panel 2. Each of the three columns culminates in an intermediate product (the maps of basement gravity domains, basement magnetic domains, and basement thickness) that is then integrated into the geological interpretation map.

Gravity domains

This map shows interpreted basement gravity values and three general gravity domains in NPRA. The basement gravity values are the result of subtracting the predicted sedimentary basin gravity effect from the isostatic residual gravity anomaly as described on poster panel 2. The northern domain encompasses a region with low to neutral gravity values – this is a region of normal, sialic density. The region labeled “dense basement” is a domain with high regional density – possibly indicating the presence of much more mafic material than in the northern region. A third domain, labeled “indeterminate basement”, in the southern portion of the map, appears to have intermediate gravity values relative to the other two domains, but we consider this domain to be poorly resolved due to uncertainties in seismic interpretations beneath the overthrusted region.

Magnetic domains

This map shows interpreted basement magnetic domains that result from the interpretation described on poster panel 3. For the most part, the predicted magnetizations of basement rocks are reasonable and sufficient to explain the observed magnetic anomalies. However, in some regions (shown in blue colors on the map), the predicted basement magnetization values are large relative to the typical range of crustal magnetization values. In these regions we postulate instead that rocks with somewhat lower intensity magnetization occur above basement within the deeper parts of the

overlying sedimentary basin. We postulate that these intra-basin sources are mafic rocks that may be related to magnetic sources in the basement beneath those locations.

3D Basement Gravity on Seismic Basement Surface

This figure is a perspective view of the basement gravity anomaly (colors) draped on the topographic relief of the seismically determined basement surface. The view is from the southwest. Note the correlation between depth to basement and basement gravity: the lowest basement gravity anomaly values occur in the northern part of the map where basement is relatively shallow whereas the basement gravity highs occur where basement is deeper in the south and southeast portions of the area.

3D Basement Magnetization on Seismic Basement Surface

This figure is a perspective view of the inferred basement magnetization (colors) draped on the topographic relief of the seismically determined basement surface. The view is from the southwest. Note the correlation between the regions of highest inferred magnetization and the deepest portions of the basin.

Geologic interpretation map

This map summarizes our preliminary geological interpretation based on the geophysical modeling and analysis. The yellow, peach, and salmon colored regions indicate three basement domains. The black contour lines show basement thickness. The northern domain is a region of low-to-neutral basement gravity, shallow depth-to-basement, thick basement, and low-to-moderate inferred basement magnetization. The central domain is a region of high basement gravity, greater depth-to-basement, thinned basement, and moderate basement magnetization (including regions where we postulate magnetic sources that are shallower than basement). The southern domain is a region of indeterminate basement gravity (because of uncertainties in seismic interpretation), greatest depth-to-basement, thinnest basement, and high basement magnetization.

Conclusions/References – Poster panel 1

The poster text emphasizes our preferred hypothesis for the interpretation of the geophysical anomalies, but other geological interpretations are possible. For example, the observed geophysical variations in the basement could reflect pre-Ellesmerian basement elements. However, we are struck by the spatial overlap of dense and magnetic basement with area of thickest Ellesmerian deposition (Bird, 1988) and increased basement normal faulting (based on the Tetra Tech seismic mapping). These relationships combined with the need for some of the magnetic source rocks to be within the Ellesmerian section (see poster panel III), creates strong ties between development of dense and magnetic basement character to at least some part of the Ellesmerian history on the North Slope. Information that could help further refine basement interpretations includes (1) better geologic and geophysical mapping and age dating of exposed mafic and ultramafic rocks in northern Alaska, (2) several deep boreholes to directly sample

basement in the NPRA, (3) higher resolution seismic data and more detailed 3D modeling in the southern portion of the study area.

ACKNOWLEDGMENTS

The authors thank Tom Moore and Jonathan Glen for careful reviews of this report. The USGS Energy Program, Alaska Oil and Gas Assessment Project, Ken Bird, project chief, supported this work.

REFERENCES CITED

Bird, K.J., 1988, Structure-contour and isopach maps of the National Petroleum Reserve in Alaska, in Gryc, G., (ed), Geology and Exploration of the National Petroleum Reserve in Alaska, 1974 to 1982: U.S. Geological Survey Professional Paper 1399, p. 355-380.