THREE-DIMENSIONAL MODELING AND INTERPRETATION OF BOUGUER GRAVITY ANOMALIES OF PLUTONIC INTRUSIONS IN THE NORTHERN MISSISSIPPI EMBAYMENT

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Bouguer gravity data for the area contained within 35° to 37°N and 87° to 92°W were processed into a regularly-gridded array using a two-dimensional interpolation scheme. This gridded data set presented a picture of the total field, to be used as input to an orthogonal polynomial trend analysis program in which the coefficients for a system of independent polynomials were set up and solved. An array of these coefficients, fitted to the total gravity field, was generated, and examined for a broad-scale trend among the lower degree polynomials. Subtracting this broad-scale trend from the original Bouguer gravity data set produced a relatively flat residual field within which the anomalies due to plutonic intrusions appeared as isolated peaks of high positive amplitude.

Using profiles taken over these gravity anomalies, preliminary maximum depth estimates were made to be used as guides in choosing a reference surface around which to begin constructing possible density models. A three-dimensional, iterative least-squares

modeling procedure, using an array of right rectangular prisms with an assumed constant density difference created a preliminary geometry for each individual anomaly. Various runs of the program were performed to derive a best-fit to the data, guided by a simple excess mass calculation.

A stack of polygonal slabs or prisms of irregular shape in the horizontal plane replaced the initial geometry produced by the preliminary modeling. A polygonal prism modeling program, employing exact gravity formulae, with the density unspecifed, compared these polygonal models to the anomalous fields to check the accuracy of the geometries and produced models in which variable densities may be specified.

These three-dimensional polygonal models were compared with previous models of the plutons, and were found to present a plausible case for representing the plutons as shallower and less massive bodies. Given the possible depths and locations of the intrusions represented by the new models, the possible effects on local stress and local earthquakes were examined, and appeared to indicate the lack of a direct connection between the intrusions and the stress and seismicity.

The models were also examined with regard to the local geology and tectonic structure of the area, the New Madrid Rift Complex and, more specifically, to the Mississippi Valley graben. It is suggested that the plutonic intrusions, rather than being considered as primary tectonic structures of the northern Mississippi Embayment, would be more profitably considered as secondary features associated with the underlying tectonic structures of the New Madrid Rift Complex.