Series of Five Maps Characterizing Geopressure Gradients Based on Mud Weight Measurements of Part of Southern Louisiana, State and Federal Waters

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INTRODUCTION

This series of five maps characterizes the subsurface pressure system of southern Louisiana, including the associated State and Federal waters. These maps were generated using the U.S. Geological Survey's (USGS) comprehensive geopressure-gradient model (Burke et al., 2012b, 2013) that delineates the regional pressure system spanning the onshore and offshore Gulf of Mexico basin, USA. Previously, the model was used to generate ten regional-scale maps (Burke et al., 2012a): five contour maps characterized the depth to the surface defined by the first occurrence of regional isopressure gradients ranging from 0.60 psi/ft to 1.00 psi/ft, in 0.10-psi/ft increments; and five supporting maps displayed the spatial density of the data used to construct the regional contour maps. Explanation of generalized geopressure gradients and pressure-regime nomenclature is given in Figure A.

The contour maps in this map series characterize the depth to the surface defined by the first occurrence of isopressure gradients ranging from 0.60 psi/ft to 1.00 psi/ft, in 0.10-psi/ft increments. The geographical extent of this geopressure-gradient model is delineated by the brown line (Figure 1, Maps 1-5), which encompasses one of the most densely drilled regions of southern Louisiana and adjacent areas. The boundary of the model represents the area of greatest well density (see maps of data density in Burke et al., 2012a) to maintain accurate contouring to the edge of the model. The pressure data were obtained from the IHS database (IHS Energy Group, 2011) and geologic folios (Dodge and Posey, 1981; Bebout and Gutiérrez, 1982; 1983; Eversull, 1984; Foote et al., 1990), which were compiled and digitally archived (Burke et al., 2011). Data quality analysis, linear-pressure interpolation calculations, and contouring algorithms defining the geopressure-gradient model are described by Burke et al. (2012b, 2013).

The isopressure-gradient trends depicted on these maps are not intended for detailed interpretation at specific locations.

PURPOSE

A comprehensive geopressure-gradient model was developed to characterize the regional subsurface pressure system of the Gulf of Mexico basin, which is one of the most important petroleum-producing provinces in the United States. The use and application of the geopressure-gradient modeling results are multidisciplinary. These isopressure-gradient maps enable the identification and quantification of the occurrence, magnitude, location, and depth of overpressured and underpressured regions, as well as zones of normal pressure. Recognition of overpressured areas is critical for the exploration of deep oil and gas resources with distinct pressure signatures, for the evaluation of reservoir-seal integrity, and for assessing potential undiscovered hydrocarbon accumulations. These maps also provide insight into potential pressure-related challenges associated with oil and gas exploration and production, which is critical for the safety and mitigation of pressure-induced geohazards related to new and ongoing exploration and development.

DESCRIPTION

This series of maps shows contours that define the pressure system of parts of onshore and offshore Louisiana. These contours represent depths to surfaces defined by the first occurrence of isopressure gradients at magnitudes of 0.60, 0.70, 0.80, 0.90, and 1.00 psi/ft, respectively. Note that the 0.50 psi/ft isopressure-gradient surface, which is quite similar to the hydrostatic isopressure-gradient surface, occurs at a multitude of non-unique depths within a single well; thus, the 0.50 psi/ft isopressure-gradient surface was not included in this mapping series. The contour interval is 200 ft, and the colored polygons are given in 1,000-ft depth increments. Cooler polygon colors (blue) represent shallower depths of the isopressure-gradient surface and warmer colors (red) represent deeper depths of the isopressure-gradient surface.

Contour control points, which correspond to well locations, are displayed on the maps as 0.5-square-mile cells. The contour control point symbols indicate the method used to determine the depth of the isopressure-gradient surface. An open blue square indicates that the depth was determined based on mud weight data. An open red square indicates that the depth was determined based on interpolation. A closed blue square indicates that the depth was determined by a combination of non-interpolated and interpolated methods because two or more contour control points reside within that particular 0.5-square-mile cell.

METHODOLOGY

The methodology for building the geopressure-gradient model, as well as details of the linear interpolation and contouring algorithms used to generate the contours of the isopressure-gradient surfaces, is described by Burke et al. (2012b, 2013). In summary, only data from vertical wells were used for this investigation, and data were systematically removed from the pressure-gradient model based on the following criteria: (1) mud weight measurement was null; (2) depth measurement was null; (3) mud weight measurement equaled depth measurement; (4) pressure gradient was less than 35% of the hydrostatic pressure gradient, which is 5.8 ppg (0.30 psi/ft); and (5) pressure gradient was greater than 35% of the lithostatic pressure gradient, which is 30.0 ppg (1.56 psi/ft).

Pressure gradients were determined on a well-by-well basis using the equations described by Burke et al. (2012b, 2013). As a result, several pressure gradients were obtained at successive depths within a single well. In order to maintain the accuracy of the pressure-gradient surface, no extrapolations of pressure measurements were conducted to supplement the existing dataset; linear interpolation was the only method employed. In the case of a pressure reversal in a well, the depth corresponding to the first occurrence of the pressure gradient, which is the shallowest depth, was used in the calculations.

The isopressure-gradient surfaces were contoured using deterministic interpolation methods which allow for calculating values between known data points. These calculated values were weighted by proximity using a two-dimensional moving ellipse. The contouring algorithm was augmented by geologic interpretation to rectify aberrant contours as necessary.

EXPLANATION

Subparallel to the present coastline, there are two, east-west trending anomalies in which the isopressure-gradient surface is located deeper than the surrounding area. These depressions of the isopressure-gradient surface signify that the pressure transition zone is also located deeper in the stratigraphic section. These geopressure-gradient depressions are observed to coincide with Cretaceous and Miocene stratigraphic sequences that prograded over the underlying, basinward-stepping shelf margins.

NON-ENDORSEMENTS

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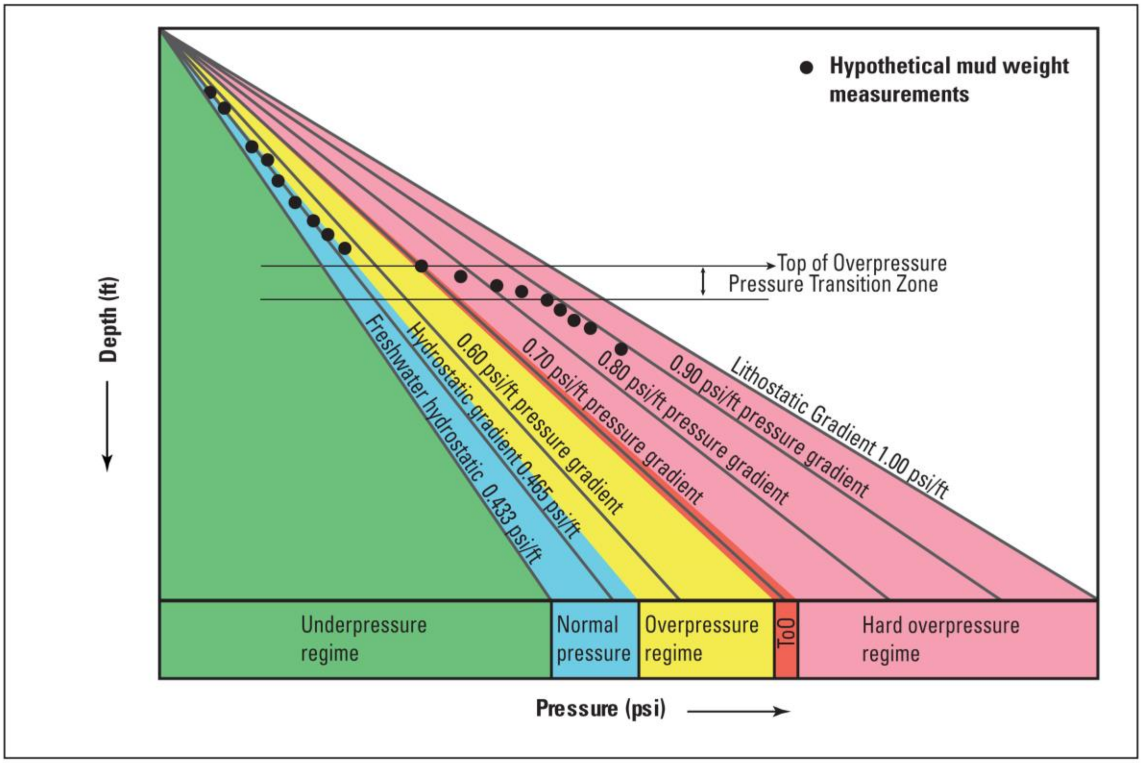

Figure A. Graphical explanation of pressure gradients and pressure-regime nomenclature. The top of overpressure is denoted by ToO. For pore water salinities typically encountered in the strata of the Gulf of Mexico basin, the hydrostatic gradient is 0.465 psi/ft (Schlumberger, 2012).