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# Effective Model Calibration for the Geologically Complex Death Valley Regional Ground-Water Flow System, Nevada and California

**Grady M. O'Brien, Frank A. D'Agnese, Claudia C. Faunt, and Wayne R. Belcher**
[All at: U.S. Geological Survey; contact: G.M. O'Brien, 520 N. Park Ave, Ste. 221, Tucson, AZ 85719, 520-670-6671; gmobrien@usgs.gov]

A numerical ground-water flow model is being constructed for the Death Valley regional ground-water system, an area that encompasses approximately 80,000 km$^2$ in southern Nevada and southeastern California. Effective construction and calibration of the regional-scale steady-state flow model, developed using MODFLOW-2000, is dependent upon integration of hydrogeologic data and parameter-estimation techniques.

A three-dimensional hydrogeologic-framework model of the region was initially constructed to provide a conceptual model of the geometry, composition, and hydraulic properties of the materials that control the regional ground-water flow system. This framework was resampled at the scale of the flow model to define the hydrogeologic units present in each of the 15 flow-model layers. In addition, there are non-traditional types of geologic data in the hydrogeologic-framework model that are used during flow-model calibration. For each hydrogeologic unit, the spatial distribution of geologic features important to the hydrologic system is defined. The volumetric cells can be populated by various hydrogeologic data such as the hydrogeologic unit, lithology, hydraulic conductivity, faulting, tectonic features, stratigraphic or lithologic facies, porosity, and derivative data calculated from these attributes.

The approach for using this arsenal of geologic data is dependent on utilizing parameter-estimation techniques available within MODFLOW-2000. The principle of parsimony is used throughout the flow-modeling process so that a simple conceptual model is methodically made more complex. Initially, the most basic conceptual model that could reasonably define the flow system was constructed and geologic units were grouped into four major hydrogeologic units. Only major geologic structures were included; there was little structural or stratigraphic differentiation, and a minimum number of parameters were used.

As the calibration process progresses, additional complexity is added to the flow model. Evaluation of the flow model is based on analysis of several MODFLOW-2000 functions such as composite scaled sensitivity, weighted and unweighted hydraulic-head and flow residuals, comparison of parameter estimates with reasonable values based on previous studies, and parameter correlations. These functions provide information on whether the available hydraulic-head and ground-water discharge data are likely to be sufficient to estimate parameter values and to subdivide parameters into more detailed units. If sufficient data are available then a parameter can be subdivided into several parameters that represent specific distinguishing hydrogeologic features. For example, in the Death Valley region the lower carbonate aquifer is widely distributed and although regionally uniform, areas with unique hydrologic characteristics exist. Although the lower carbonate aquifer was initially considered one hydrogeologic unit with one set of hydrologic properties, it has been progressively subdivided into different structural and stratigraphic regions with unique hydrologic properties. The best flow model consists of the fewest number of parameters that can adequately describe the flow system and meet the modeling objectives.