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**Quantitative Analysis of Sandstone Intrusion Networks, Panoche Hills, California**

Sand dikes and sills cut a 500-m thick marine shale package (Moreno Shale) in the Panoche Hills, California. The network of sand bodies served as a permeable network to drain rapidly deposited sediments in the Cretaceous Great Valley forearc. That drainage contributed to the development of cold seeps on the seafloor. The injection network served as a well-connected horizontal and vertical plumbing system that would have been overlooked if a purely depositional model were applied to the shale-dominated succession. A small volume of injections, with varying degrees of tortuosity, connects all sand bodies via injections ranging in size from millimeters to meters. Geological models suggests that <5% volume sands increase permeability by 3 orders of magnitude. The sand intrusion network consists of two basic elements:  

- A lower, complex network of dikes and sills that extends about 200 m above the parent sands in the Panoche Sandstone. Dikes dip within ±30° normal to bedding. Strike orientations range through a full 360°. Sills are found bedding sub-parallel (±30° parallel to bedding) and often run both parallel and oblique to bedding along their length.  
- An upper population of bedding-normal dikes with a consistent strike orientation and small strike variation (±20°) and little dip variation.

Neither dikes nor sills contain internal fabrics. Laser particle size analysis (LPSA) shows grain sizes are uniform, bellying any intrusion mechanisms that modify the original grain-size distribution. An isotropic stress state near the parent sand is favored, since both dikes and sills form without a strike orientation preference. Higher up, dikes intruded normal to the folds developed in the Great Valley Sequence, suggesting some regional structural control.