

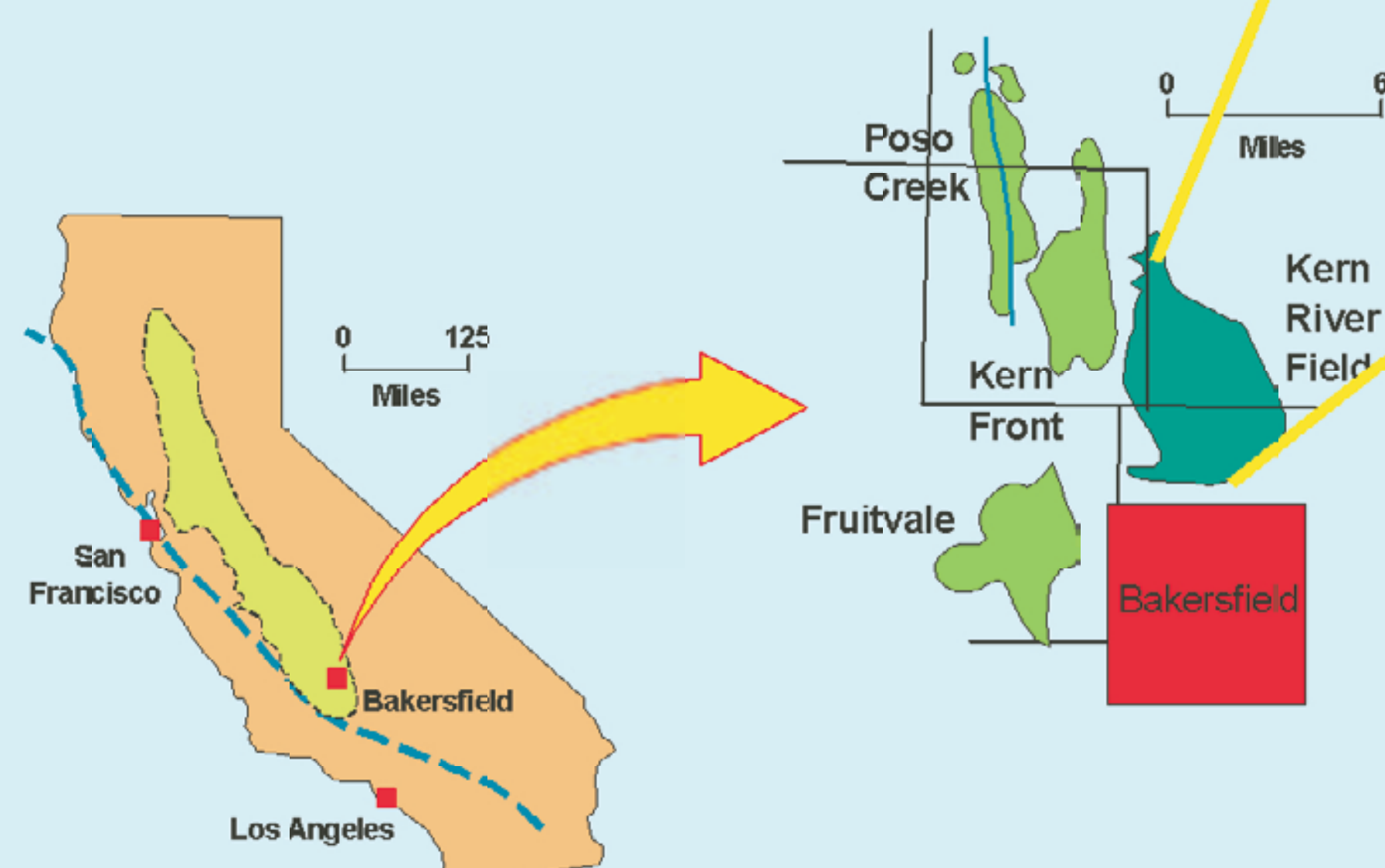
ANALYSIS OF LOW PERMEABILITY INTERVALS IN A HEAVY-OIL BRAIDED STREAM DEPOSIT USING A COMBINATION OF CORE AND LOG ANALYSIS, KERN RIVER FIELD, CALIFORNIA

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Introduction

The Kern River field is located in Kern County, California, immediately adjacent to the city of Bakersfield (Figure 1). This super-giant oil field has produced over 1.5 billion barrels of 12-degree-API gravity crude during the last 103 years from a Mio-Pleistocene braided stream deposit (the Kern River alluvial fan) (Figures 2, 3, and 4). Estimated reserves are still substantial. Production of over 100,000 BOPD places this field in the top five producing fields in the country. Zones of reduced reservoir quality due to poorly sorted sand, siltstones, and minor amounts of clay are resulting in unproduced pockets of the reservoir rock with residual oil saturations 10-30 saturation units higher than the adjacent rock with higher permeability. Some of the lower quality reservoir rock is already heated to 220 degrees (F) or greater and shows no sign of draining. Other areas have been noted with high oil saturation which appear not to be draining and are at lower temperatures than the surrounding rock. A study is underway to determine if the lower permeability (rock quality) is the sole reason for the pockets of high residual oil. 70 cores taken over the last 30 years are being reviewed, along with core photographs, wireline logs, and 3D models to determine the character of the targets and their extent. Two examples (Toltec lease and Mitchell lease) of by-passed oil are reviewed here.

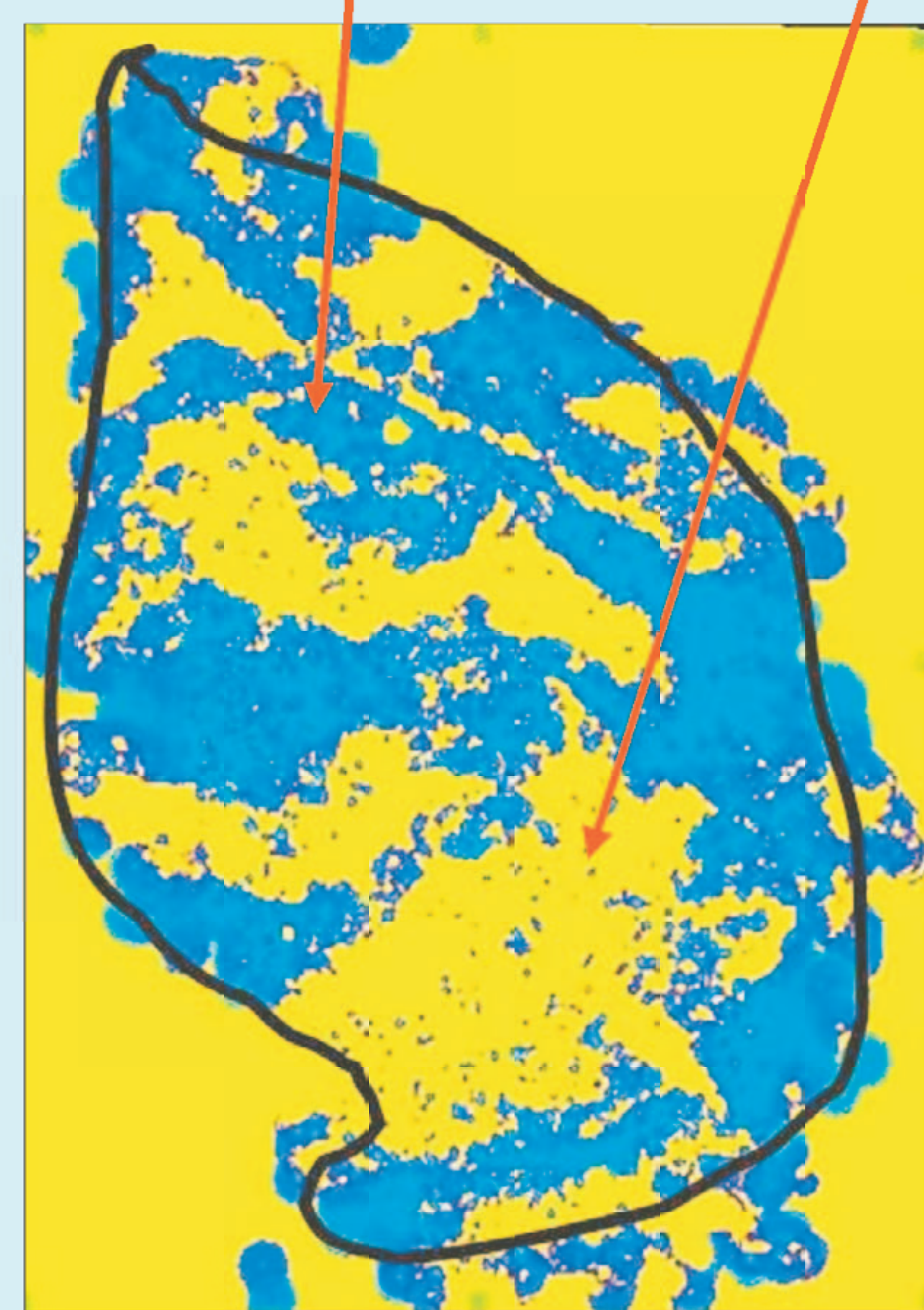
KERN RIVER LOCATION



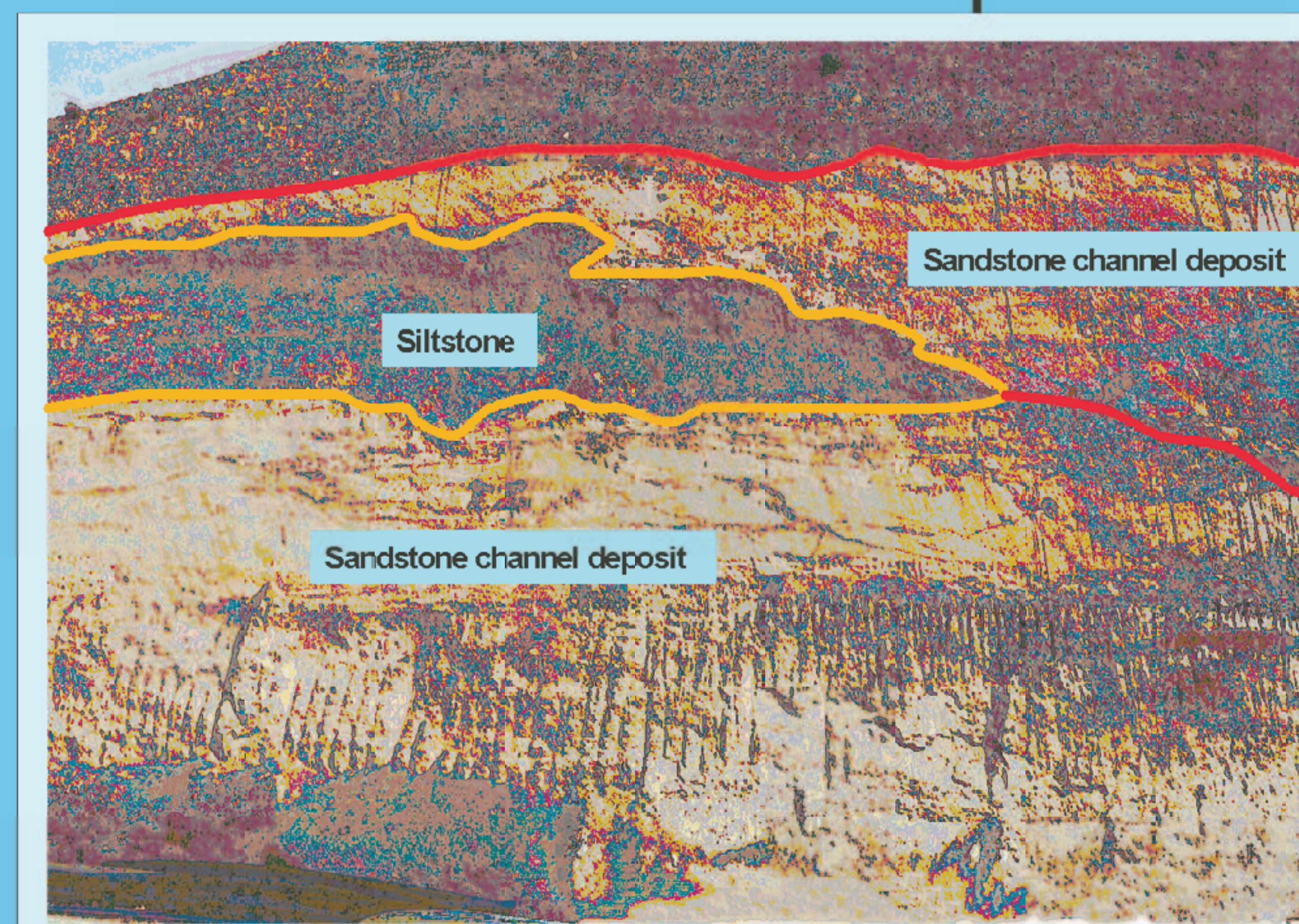
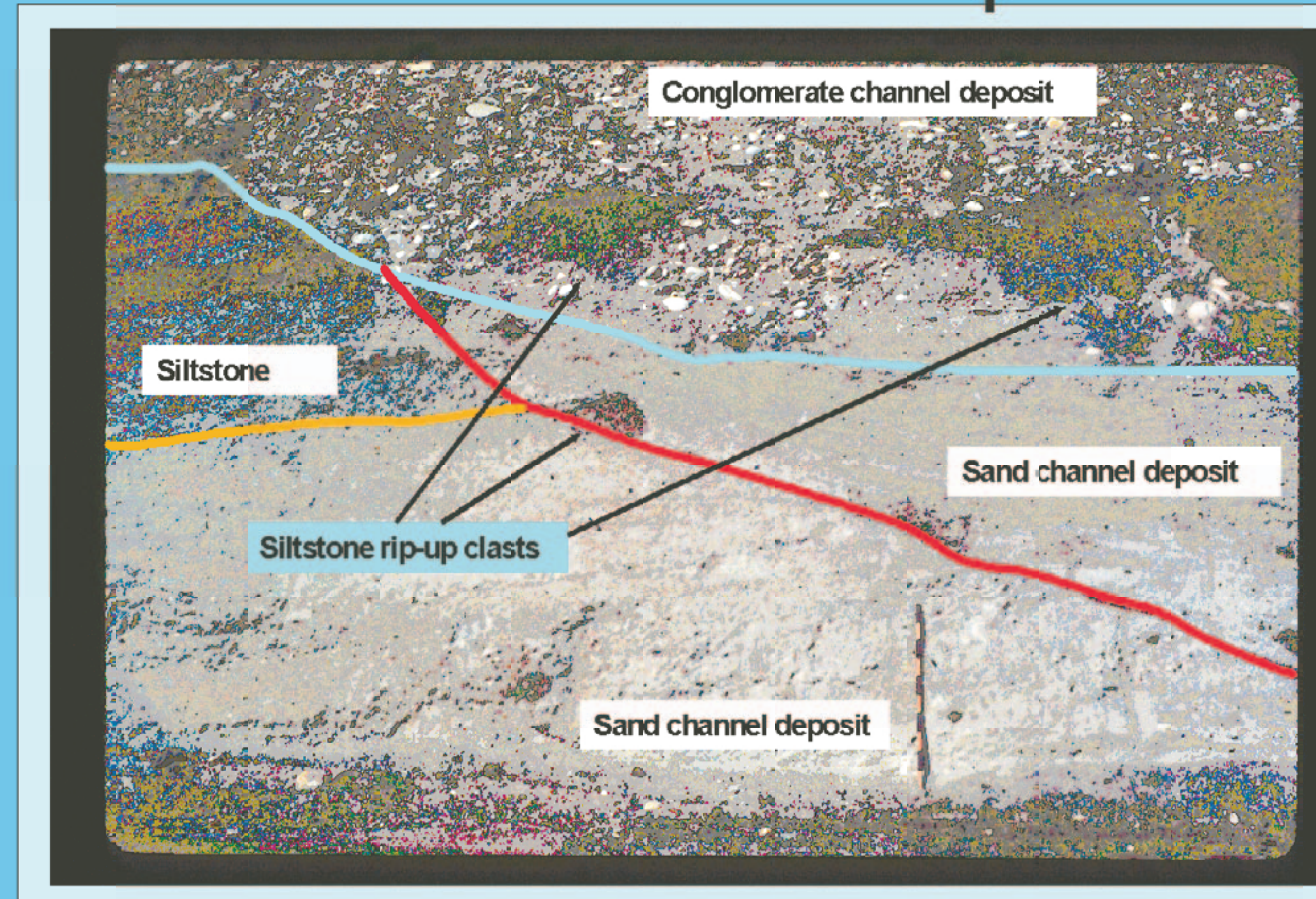
Cross-bedding, indicating a uniform direction of current flow to the right, separated by a conglomerate longitudinal bar deposit and suggesting water depths of up to 10 feet.

Fluvial Sand Channels and braided stream beds (blue)

Overbank Siltstone/shale (yellow)



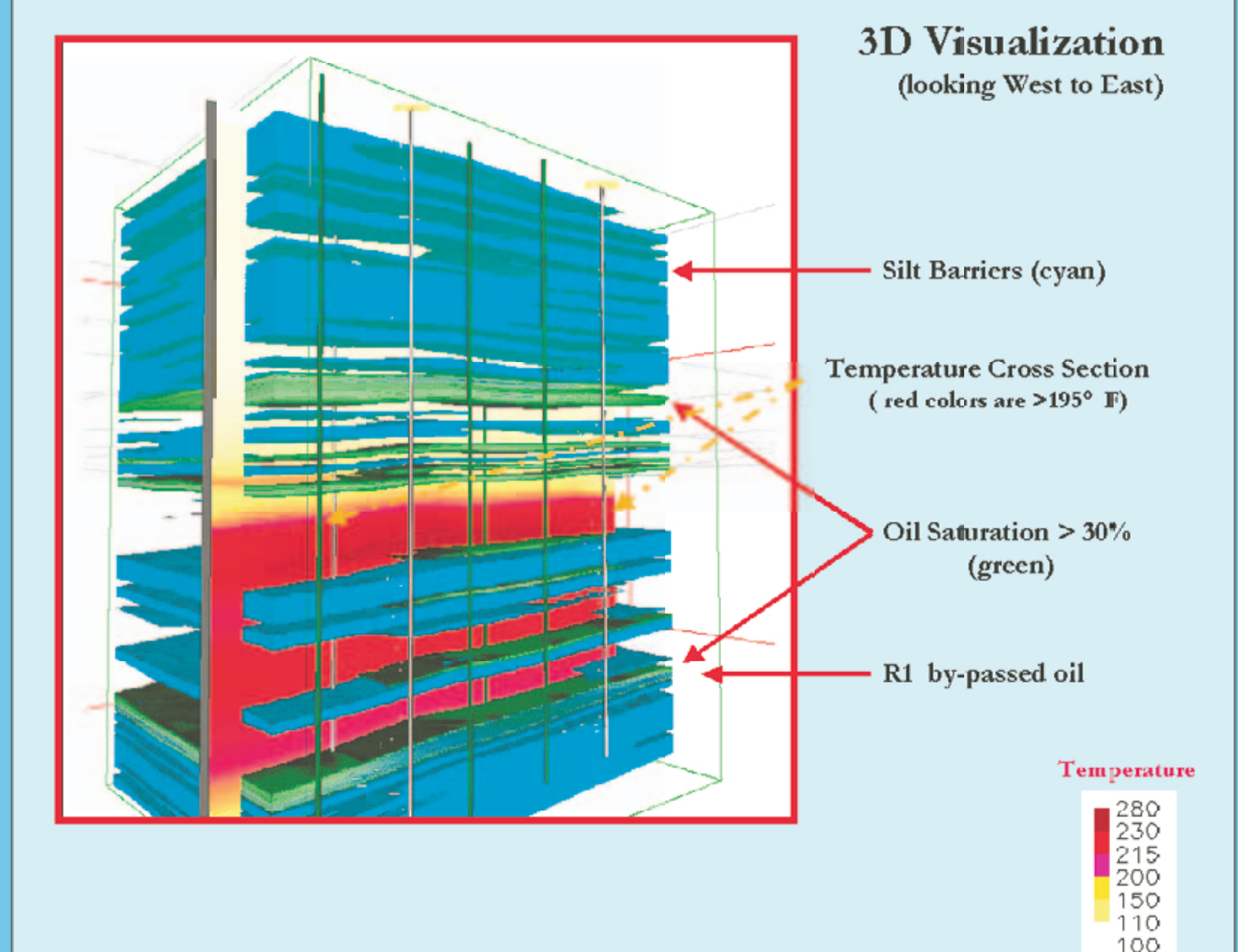
A horizontal slice through a 3D cube of resistivity data consisting of 9000+ log traces. Slicing down through these data reveals the channels, braided stream beds, and overbank deposits that make up the Kern River Formation (KRF).



Outcrops of Kern River Formation, showing typical examples of the fluvial deposits of the Kern River alluvial fan.



Trough cross-bedding, medium- to coarse-grained, pebbly sand. The outcrop is well preserved because the sediments are oil-soaked. This section is stratigraphically equivalent to the middle portion of the Kern River Formation.



3D model of the KRF showing lithology, oil saturation, and reservoir temperature. This type of modeling is done routinely on a field-wide level down to the individual well level.