MAGNETOSTRATIGRAPHY, TEPHROCHRONOLOGY, AND STRATIGRAPHIC ARCHITECTURE OF THE WESTERN BORREGO BADLANDS, ANZA-BORREGO DESERT STATE PARK, CALIFORNIA

Paul Remeika
State Park Ranger I (retired)
Colorado Desert District
Anza-Borrego Desert State Park

This chapter introduces an integrated magnetostratigraphic, tephrochronologic, and stratigraphic study of the Plio-Quaternary fluvio-lacustrine sequence exposed in the western half of the Borrego Badlands, Anza-Borrego Desert State Park, California. Reliable high-resolution magnetostratigraphy from a relatively poorly-dated sedimentary sequence (approximately 687 m-thick)exposed in the main drainage arroyo of Rainbow Wash in the southern Borrego Badlands has been accomplished. Proxy stratigraphic marker horizons are used for the construction of a composite magnetostratigraphy between the sedimentary records of Rainbow Wah and Mammoth Cove.

Unaltered Rainbow Wash sediments preserve a recorded pattern of Class 1 magnetic reversals (C2r-C1r) that correlates well with the known geomagnetic polarity time scale for the past 2.5 m.y. The observed polarity patterns obtained from the sequence shows that a reliable magnetostratigraphy is established spanning the late Pliocene to early Pleistocene, including the top of the Gauss normal-polarity chron (C2An)/Matuyama reversed-polarity chron (C2r) geomagnetic boundary at approximately 2.581 Ma throught the Olduvai normal-polarity subchron (C2n) at approximately 1.950-1.770 Ma. The Olduvai straddles the internationally recognized Pliocene-Pleistocene boundary at approximately 1.8 Ma. Based on sampling bias, it was not possible to determine the short-lived Reunion normal-polarity subchron (C2r.1n) at approximately 2.150-2.140 Ma.

This study modifies and expands upon the well-dated foundation developed by Paul Remeika and Sue Beske-Diehl for the Mammoth Cove section (approximately 200+ m-thick) whereby a reliable magnetostratigraphy is established, documenting the Jaramillo normal-polarity subchron (C1r.1n) at approximately 1.07-0.99 Ma through the Matuyama reversed-polarity chron (C1r)/Brunhes normal-polarity chron (C1n) geomagnetic boundary at approximately 0.78-0.77 Ma. Furthermore, an added element of chronologic control is provided by the application of tephrochronology to the uppermost Mammoth Cove sedimentary sequence. Two distally-derived fallout silicic rhyolitic tephra layers are identified, both derived from the Long Valley-Glass Mountain volcanic center north of Bishop, California, including the Bishop ash bed (PR-BB-8), a master tephra dated at approximately 758 ka, and the ash of Thermal Canyon (PR-BB-8) dated at approximately 740 ka. Identity is based on chemical fingerprinting of volcanic glass shards separated from the tephra. Glass shard samples were analyzed by electron microprobe. These tephra layers chemically correlate to the aforementioned isotopically-dated tephras and record individual, basin-wide chronohorizons. Each provides a very strong constraint that not only supports the research by, but refines the seminal work of Remeika and Beske-Diehl.

Furthermore, six additional tephra layers preserved below the Matuyama/Brunhes boundary correlate stratigraphically and paleomagnetically to a characteristic sequence of Bishop ash-like tephras known regionally as the Upper Glass Mountain family of tephra beds. At Mammoth Hill, the recent discovery of the Lava Creek B ash (PR-BB-10), derived from an eruptive event in the vicinity of Yellowstone National Park that occurred at approximately 660 ka, will most certainly provide more exact age control of the sequence. Samples of this volcanic ash bed were turned over to the Colorado Desert District for analysis on 1-03-05 and I look forward to receiving the results soon.

The western half of the Borrego Badlands is a tectonically-controlled depositional basin, developed as part of the Colorado Desert Breakaway Margin fragmentation that commenced during the Oligocene-Miocene with the introduction of predominantly north-northeast-dipping, low angle normal faulting (lithospheric stretching) along the western margin of the Salton Trough. A Plio-Quaternary episode of northweste-southeast directed range-normal crustal extenstion (block faulting) followed, and resulted in the stepped-down development of several asymmetric half-graben sedimentary basins, including the Borrego Badlands, within the seismogenically-active, basin-bounding San Jacinto Fault Zone. The basin is obliquely flanked by imbricate tilt-block mountain ranges (e.g., Coyote Mountain and Santa Rosa Mountains) that are composed on Paleozoic metasedimentary rocks and Mesozoic crystalline and mylonitic rocks.

Locally-distributed basin-margin deposits consist of genetically-linked, asymmetric sediment-thickness depositional sequences, part of the Anza-Borrego Group. Sediments are synextensional, footwall-derived coarse-clastic alluvial fan conglomerates of the Pleistocene Ocotillo Conglomerate. Basinward, these sequences are stratigraphically limited as the Bautista beds, with sandstones, and finer-grained floodbasin facies transitions that graphically intercalate with the impinging suite of shallow freshwater lacustrine lithofacies typical of the Colorado River Group basin-fill into the Salton Trough. Because of the close association with deposits of lacustrine origin, many prograding sandstones represent distal alluvial plain/fan delta deposits. Basinal lacustrine sediments include a complex succession of freshwater delta fill claystones and siltstones of the Borrego Formation and Palm Spring Formation (restricted to east of Third Wash), and lakebed claystones, siltstones, and shoreline tufas of the upper and lower Brawley Formation, separated by the stratigraphic pinchout of the Mammoth Cove Sandstone (oftentimes erroneously represented as the Ocotillo Conglomerate) sourced from the Canebrake Conglomerate.