eroded valley. The present structure at the top of the J sandstone (stratigraphically older than the D sandstone) is a structural low in the area where D valley-fill sandstones occur. The trend and location of the low at J level are identical to the trend and location of the D valley-fill deposits. Thus, the present low at the J level confirms the paleostructure interpretation.

This new model for D sandstone deposition, incorporating paleotopography and sea level changes, provides a new idea for petroleum exploration in the Denver basin.

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Basement Fault Configurations, Wyoming Province

For many basement-cored folds and related mountain flank faults in the Wyoming province, locally balanced cross sections can be constructed using structural relief and line lengths in the sedimentary cover rocks. By conserving the length of the upper basement surface, possible basement fault movement can be inferred. This faulting includes: (1) motion along a reverse fault which yields a folded upper basement surface, and (2) displacement distributed along a series of parallel basement faults. The sedimentary cover rocks are force folded and may be cut by mountain flank faults which place Precambrian rocks overlying either Paleozoic or Mesozoic rocks. Previously recognized thrusts, blind thrusts, rootless anticlines, and buckle folds in the cover rocks in adjacent basins are reinterpreted to represent thin-skinned deformation related to basement faulting. Where there is relative translation of the cover rocks, cross sections need not balance locally and the fault dips and basement geometries previously determined are in error. The fault dips calculated from locally balanced cross sections have been overestimated, and/or the displacement on the basement fault(s) has been underestimated. The displacement observed on mountain flank faults may be far less than the total displacement on the basement fault. In the simplest case, it may be possible to project the mountain flank fault downdip to infer the orientation and location of the basement fault(s) at depth.

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Correlation of Twin Creek Limestone with Arapien Shale in Arapien Embayment, Utah—Preliminary Appraisal

Striking and important stratigraphic patterns have emerged as a result of recent work during which members of the Twin Creek Limestone were correlated with the Arapien Shale, all of Middle Jurassic age. These correlations, determined first on the basis of electric and lithologic logs, are supported by recent palynologic work.

Three distinct dinoflagellate assemblages, assigned to the Bajocian(?), Bathonian, and Callovian stages, form the paleontologic basis for these correlations. The Bajocian(?) assemblage is found in rocks of the Sliderock and Rich Members of the Twin Creek Limestone. The Bathonian assemblage is found in units of the Boundary Ridge and Watton Canyon Members of the Twin Creek, and also in units of the lower Arapien Shale (lower Leeds Creek Member of the Twin Creek of Wyoming). The Callovian assemblage is found in rocks of the upper Arapien (upper Leeds Creek and Giraffe Creek Members of the Twin Creek of Wyoming).

Isopach maps, based on these correlations, indicate that most of central Utah was the site of a large marine embayment—the Arapien embayment—that was flanked on the west, south, and east by highlands. The maps also suggest that the ancestral Uinta Mountains, a submerged feature, affected sedimentation as early as Bajocian time, and became a significant barrier from the late Bathonian through Callovian. In central Utah, marine carbonates were deposited in the Arapien embayment during deposition of the Gypsum Spring through Watton Canyon Members of the Twin Creek Limestone. During deposition of the Arapien Shale, a major northward regression occurred; the embayment shrank to form a smaller basin—the Arapien basin—that lay directly south of the ancestral Uinta Mountains. Most of the Arapien Shale is shallow-water deposits, that formed in the basin under hypersaline conditions.

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Overstep Thrust Sequence Development in Winnemucca Fold and Thrust Belt, North-Central Nevada

The Sonoma Range lies at the western edge of the Winnemucca fold and thrust belt of north-central Nevada in which lower Paleozoic rocks are thrust westward over para-autochthonous Triassic shelf rocks that overlie Mesozoic autochthonous lower Paleozoic rocks. Evidence from this range indicates that the Winnemucca thrust sequence developed in overstep, rather than piggyback, fashion.

This assertion is based on fabric elements of the Triassic rocks and on the assumption that the style and attitude of a given fold reflect the relative proximity of thrusts at the time of formation of said fold. The data may be summarized as follows: (1) four generations of Winnemucca-age folds are recognized; all are west verging and show the same sense of asymmetry; (2) in succeeding generations, the apical angle of folds increases and axial planes change from nearly horizontal to nearly vertical; (3) also in succeeding generations, deformation becomes more penetrative, and shortening and hinge thickening decrease. If the Winnemucca thrust system were to have developed in piggyback manner, one would expect subsequent deformations to progress from open to tight folds, upright to recumbent folds, and little to much shortening, and to remain relatively uniform in degrees of penetrativeness and thickening in the hinge.

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Bioerosion in Rocky Intertidal Zone of Northern Gulf of California

Pleistocene sedimentary rocks exposed in the intertidal and shallow subtidal zones of the northeastern Gulf of California coastline are being significantly weathered and eroded by a diverse suite of biologic agents. Macroscopic bioerosion of carbonate substrates in this region is universal, although the distribution patterns of particular taxa of borers are patchy.

In the vicinity of Puerto Penasco (Sonora, Mexico), where the tidal range achieves a maximum of 9 m (30 ft), the dominant macroboring organisms include mytilid bivalves (*Lithophaga*), sipunculid worms (*Phascolosoma* and *Themiste*), and clinoid sponges (*Cliona*). Abundances are locally high (e.g., up to 120 sipunculids per 1,000 m^3 of rock). Other prominent but slightly less abundant borers include bryozoans, regular echinoids, and polychaete annelids (eunicids, spionids, and possibly sabellids). Nestlers, which are organisms that occupy and sometimes modify or enlarge preexisting borings, are common. They include bivalves (mainly arcids and petricolids) and crustaceans (various crabs and shrimps).

Data on the distribution of borers with respect to intertidal microfacies are not sufficient to permit much generalization at this point in the investigation. However, it is clear that substrate character is an important factor. Poorly cemented beachrock (sandstone composed of bioclasts and volcanic rocks fragments) is bored intensely by bivalves and sipunculids. Limestone coquina is colonized by dense populations of boring bivalves and sponges. Loose shell material commonly contains borings of sponges and polychaetes.

To determine bioerosion rates and colonization sequences of boring taxa, experiments with marble slabs staked out at numerous sites are in progress.

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Paradox Basin: A Model Pull-Apart Basin of Pennsylvanian Age

The Paradox basin of the east-central Colorado Plateau province is an elongate, roughly rhombic salt basin of Middle Pennsylvanian age. it is bounded on the northeast by the Uncompahgre-San Luis segments of the Ancestral Rockies. The writers have demonstrated previously that the