pipes located in and near Grand Canyon. Mineralization age is uncertain and ranges from Laramide-Sevier to Mississippian age.

The Sr alteration of the Paleozoic limestone of the Grand Canyon region is also affirmed by a large increase of the Sr-isotope ratio of the modern surface water of the Colorado River; Upstream of Grand Canyon the Sr ratio of river water is about 0.7092, but downstream it is about 0.7106 (P. J. Patchett, written commun., 2000). For a large river, this radiogenic Sr increase is pronounced, but seems generally proportional (1) to the ground-water volume and (2) to the above-suggested widespread Sr-isotope content of the present-day spring discharge into the river in Grand Canyon. Modern upper Colorado River surface water within the Grand Canyon presumably mixes with discharging ground water having a high radiogenic Sr content derived from altered Paleozoic carbonate rock adjacent to the Grand Canyon. In a similar situation, some of the Late Miocene, ancestral upper-Colorado-River water was recharged and flowed through the same altered Paleozoic carbonate rock and became the high radiogenic-Sr ground water of the paleoaquifer that deposited the Hualapai limestone.

VAN HOESEN, JOHN G.
DEPARTMENT OF GEOSCIENCE, 4505 MARYLAND PARKWAY UNIVERSITY OF NEVADA, LAS VEGAS, 89154-4010.

A preliminary assessment Of the glacial geology and geomorphology of Great Basin National Park, east-central Nevada.

Great Basin National Park (GBNP) is located in east central Nevada approximately 286 miles north of Las Vegas. The park includes much of the southern Snake Range rising to a maximum elevation of 3,982 meters at the summit of Wheeler Peak. The park is located in the Great Basin, a portion of the Basin and Range physiographic province that drains internally. Centered on the state of Nevada and extending from southern Oregon to western Texas, the Basin and Range Province is an immense region (~ 200,000 mi.2) of alternating, north-south trending, faulted mountains and flat valley floors. Topographically high regions like the Snake Range are found throughout the Great Basin and produce drastically different microclimates from the surrounding low lying valleys. For example, the high peaks of the Snake Range provide refuge for the only remaining active rock glacier in the interior Great Basin. Thus, the climate of GBNP is the closest modern analog we have for Late Quaternary climatic conditions.

It has long been recognized that the southern Snake Range in GBNP was glaciated during the last Ice Age. Early explorers (Gilbert, 1875; Simpson, 1876; and Russell, 1884) first described glacial features in the Snake Range and subsequent authors have continued to substantiate their reports (Weldon, 1956 and Kramer, 1962). However, little research had been conducted on the glacial history and paleoclimate of GBNP since this early reconnaissance work. There have been numerous studies on glaciation and paleoclimate throughout the Great Basin but to prior to this study, there had not been a formal investigation into the glacial geology and paleoclimate of the Snake Range and GBNP (Osborn and Bevis, 1997 and Osborn, 1988).

This study presents a preliminary map of glacial deposits and landforms in Great Basin National Park. The general surficial geology and glacial geomorphology has been mapped at a scale of 1:24,000 including the location and extent of cirques, moraines, and an active rock glacier. Relative age constraints have also been developed for prominent glacial deposits following the guidelines of Blackwelder, 1931; Sharpe, 1938; Birkeland, 1964, 1974; and Wayne, 1984.

WILLIS, G.C., BIEK, R.F., HIGGINS, J.M., DOELLING, H.H., HYLLAND, M.D., HURLOW, H.A., and SOLOMON, B.J.

New Geologic Mapping in Utah's Dixie, St. George Basin and Zion National Park, Southwest Utah

The St. George basin is experiencing some of the most rapid urban growth in Utah. Because of its setting in a tectonically active area with extensive shallow and exposed bedrock, many geologic concerns have arisen. These include an unusually large variety of geologic hazards, limited industrial minerals needed for construction, water supply issues, unique geologic features that merit preservation, and conflicting land management plans that generally have a geologic component.

As a result of these concerns, in 1994 the Utah Geological Survey (UGS) Mapping Program began an extensive geologic mapping effort in the basin. Currently, we have completed ten 1:24,000-scale quadrangles that were funded with a 50:50 cost share under the National Cooperative Geologic Mapping Program. In 1996, the UGS Mapping Program expanded its efforts and began a project to map the eight quadrangles encompassing Zion National Park. This project is nearing completion and was funded in part by the National Park Service (NPS).

Thus, since 1994, the UGS has published or is nearing completion of 18 1:24,000-scale geologic maps in the greater St. George basin area. These maps provide unprecedented geologic map coverage of over 2,700 km2 across the western margin of the Colorado Plateau and adjacent transition zone with the Basin and Range Province. Already, the maps have served as the basis for a GIS-based geologic hazards map folio of the burgeoning St. George basin; as a guide to ongoing paleoseismic investigations of the Hurricane fault zone; as the foundation for general-interest geologic reports on Zion National Park, and Quail Creek and Snow Canyon State Parks; and will form an important GIS layer in the NPS's Zion National Park Resource Management Area database. The maps have also been a critical resource in ongoing efforts to set aside habitat for the endangered desert tortoise, and to delineate scarce sand and gravel resources before they are covered by construction.

These geologic maps provide a wealth of new data, but like any good maps they raise as many questions as they solve. We know, for example, that long-term downcutting rates vary systematically along the Virgin River, yet river terraces remain poorly dated and poorly correlated across the region. We have mapped the extent of debris-flow deposits high on the Kolob Terrace, but the age and significance of these deposits are imperfectly understood. At the base of the Cretaceous section, we have identified strata of late Early Cretaceous age that have affinities with the Cedar Mountain Formation of central and eastern Utah, but regional correlations remain uncertain. The list goes on and on, but one thing is clear - these maps and reports should provide a regionally coherent base from which to launch future, more detailed geologic studies.

YOUNG, RICHARD A.

Laramide uplift of the Colorado Plateau in NW Arizona

The Hualapai and Coconino Plateaus in northwestern Arizona preserve Laramide-age arkosic sediments and partially exhumed fluvial channels incised into the tilted and erosionally beveled margin of the southwestern Colorado Plateau. The Paleogene surface is buried under late Oligocene to middle Miocene volcanic rocks at several localities. A 1200-meter-deep major paleocanyon is incised into Proterozoic bedrock along the downthrown side of the modern trace of the Hurricane fault in Peach Springs Canyon. Gravel clasts in the late Cretaceous(?)-Paleogene canyon fill preserve a record of Laramide erosional unroofing in which clasts of Proterozoic rocks increase in percentage upward in stratigraphic sections. Laramide volcanic clasts in similar arkosic gravels preserved east of the Hurricane fault increase to more than 50 percent of total clasts near the tops of some sections. The volcanic clasts record syntectonic volcanism and sedimentation coincident with Laramide deformation, probably beginning in late Cretaceous time. Ages of 14 randomly selected volcanic clasts range from 64 to 117 Ma, with the majority falling in the interval from 72 to 84 Ma. This upsection increase in volcanic clasts probably records the late Cretaceous migration of the volcanic arc toward the modern Plateau margin late in the period of arkose deposition.

Sixty kilometers south of Grand Canyon, a 30-meter-thick freshwater limestone within the Laramide arkosic sediments contains fossil charaphites, stromatolites and gastropods, including Viviparus, Physa, and Lioplacodes. These gastropods are similar to the suite of Genera found in the Paleocene-Eocene rocks of SW Utah, such as the Claron Formation. The early Tertiary lake extended at least 17.5 km in an east-west direction.

The age of the arkosic sediments, along with evidence of younger extensional backtilting of the Laramide channels, indicates that the edge of the Colorado Plateau in Arizona was previously higher than the existing 1200 meters above contemporaneous sea level when channel incision occurred in late Cretaceous or Paleocene time. The amount of inferred Laramide regional northeast tilting is of the same order of magnitude as the paleoslope preserved by structure contours on the Kaibab Formation in northern Arizona.

Although these data cannot entirely preclude a small amount of lateTertiary uplift, there is no compelling evidence for significant late Miocene or Pliocene uplift of the southwestern margin of the Colorado Plateau in this part of northwestern Arizona. The existing topographic relief along the western border of the Hualapai Plateau is approximately equal to the structural offset recorded in the extensional displacement of the Miocene Peach Spring Tuff. The Laramide structural history recorded in the Cretaceous(?)-Paleogene sections in Arizona is similar to the more detailed tectonostratigraphic record in southwestern Utah for a comparable time interval.