the most extensive rocks in the quadrangle are Tertiary volcanic units. These include regional ash-flow tuffs (Needles Range Group, Isom Formation, Quichapa Group, and Racer Canyon Tuff) from calderas outside the area to the NW and W, more local ash-flow tuffs (Rocks of Paradise and Rencher Formations) derived from Iron Axis laccoliths to the south, and local volcanic rocks from vents within the map area. In the map area the volcanic rocks generally get younger from west to east (Needles Range, Isom, Quichapa, Rocks of Paradise, Rencher, and Racer Canyon). In the east the 19 Ma Racer Canyon Tuff is subhorizontal. Erosion of the east-tilted fault-block resulted in semi-consolidated, late-Miocene (~8-9 Ma) alluvial deposits located in the southwest. The youngest igneous rocks are sub-horizontal to gently east-dipping basalts also restricted to the southwest.

Historically, K/Ar mineral dates provide the main age constraints on the Miocene volcanic stratigraphy and Iron Axis magmatism of this region. We present the results of 40Ar/39Ar incremental release dates on plagioclase separated from six volcanic samples collected in the Pinto Quadrangle. The age of the Harmony Hills tuff (Quichapa Group), a key unit deformed by all of the intrusions, is only poorly constrained by six prior K/Ar dates ranging from 24.4 to 20.3 Ma. We obtained a well-defined plateau age (8 steps constituting 91% of the total 39Ar) of 22.03±0.15 Ma. This date is indistinguishable from a 21.93±0.07 Ma date (40Ar/39Ar, biotite) reported for the immediately overlying ash-flow tuff member of the Rocks of Paradise Formation (Hacker et al., 1997, GSAA). We also obtained a well-defined plateau age of 21.83±0.17 Ma (4 steps, 55% total 39Ar) on the Rencher Formation (and concordant isochron age of 21.46±0.40 Ma) which directly overlies the Rocks of Paradise. These data tightly constrain the age of several key volcanic units in the area as well as their sources to the south and west (Stoddard Mountain, Pinto Peak, and Bull Valley intrusions). Unfortunately, four of our samples gave U-shaped, discordant, age spectra suggesting either the presence of excess argon or xenocrystic contamination. The least contaminated sample (an east-tilted capping basalt at the southwestern end of the map area; Gum Hill) yielded a minimum age increment of 5.7 Ma which we interpret as a maximum age for the rock. If correct, this interpretation suggests that some of the Miocene capping basalts throughout the area may be younger than indicated by prior K-Ar ages (i.e, ~7.7 Ma, Bull Valley Mountains, Best and others, 1980, AJS).

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ERSKINE, M.C.

Extensional tectonics in a regional thrust belt – a simplified structural model for the interpretation of the central Basin and Ranges in Utah and Nevada.

During the Mesozoic, the sedimentary rocks of the miogeocline of western Utah and eastern Nevada were thrust eastward over the North American continental margin. During the Cenozoic, this folded and thrusted terrain extended westward, essentially opposite to Mesozoic vergence. The miogeocline consists of Eocambrian to Jurassic paraconformable sedimentary rocks over 12 kilometers (40,000 feet) thick in western Utah and eastern Nevada.

Stratigraphic/structural Relief across the twenty mile width of Steptoe Valley, between outcrops of the Jurassic Navajo (Aztec) Sandstone at Curry Junction and outcrops of Eocambrian quartzite north of Cherry Creek, is as much as twelve kilometers. Clasts of Prospect Mountain Quartzite in the basal conglomerate of the Cretaceous(?) to Eocene Sheep Pass Formation indicate at least seven and a half kilometers of EXPOSED stratigraphic relief by early Sheep Pass time.

Regional Outcrop Patterns – The major mountain ranges (Fish Springs/House/Wah Wah Range; Raft River/Pilot/Goshute/Deep Creek Range/Snake/Highland; Ruby/White Pine/Grant/Quinn Canyon/Groom Range; Toiyabe Range) form antiformal linear structural culminations. Cambrian quartzite and older sedimentary rocks are in the core. The ranges are separated by synclinoria of structurally dismembered younger sedimentary rocks (Confusion Range; Buttes Range; Sulphur Springs-Monitor Ranges). The synclinoria show significant packages with clear westward structural vergence on their eastern limb. These synclinoria preserve miogeoclinal sedimentary rocks as young as Jurassic Navajo Sandstone in their cores (Buttes Range Synclinorium near Curry, Nevada). Outcrops of Cretaceous sedimentary rocks are rare and consist of nonmarine clastics. Outcrops of pre-miogeocline crystalline basement are rare beneath the thick sections of Eocambrian clastic rocks.

Structural Models – This poster presents a series of simplified balanced cross sections illustrating a model of Basin and Range tectonic development in time and space. The model demonstrates that the key to understanding of the Basin and Ranges tectonic development lies in understanding the style of Mesozoic thrusting.

FERGUSON, C.A., SKOTNICKI, S.J., and McINTOSH, W.C.

Temporal and spatial patterns of extension along the southern boundary of the Transition Zone, Superstition volcanic field, Arizona

The 20.5 – 18.0 Ma 5,000 km^2 Superstition volcanic field straddles the Transition Zone – Basin and Range structural boundary in central Arizona. High-precision, sanidine, single crystal, laser fusion $^{40}Ar/^{39}Ar$ dating of key volcanic units provide a detailed chronology of the evolution of tilt domains and magnitudes of extension throughout the life of the field. In the Transition Zone, even the oldest volcanic strata are either undeformed or only gently tilted, but locally, fanning dip sequences in narrow grabens are preserved. In the Basin and Range, northeast tilting began at about 20.5 Ma and was fairly evenly distributed along closely spaced faults throughout the field until eruption of Apache Leap Tuff at 18.6 Ma. Tilting ceased in most areas by 18.6 Ma, but continued along discrete zones, locally very rapidly, until about 18.0 Ma.

The E-W elongated 350 km^2 Superstition cauldron (source of the Apache Leap Tuff), lies in the northwestern corner of the field and is bisected by the southwestern structural boundary of the Transition Zone. Northwest of the cauldron, the boundary fault zone was active until about 18.0 Ma, and southwest-side-down normal motion was accompanied by about 2 kilometers of dextral offset between 18.6 and 18.0 Ma. Extension to the southwest of this segment of the boundary, in the Goldfield Mountains, was moderate to extreme. South of the cauldron, the boundary zone turns sharply to the east and extends into the Globe-Miami area. Extension to the south of this boundary was weak to moderate but distributed over a larger area than in the Goldfield Mountains.

The sharp turn in the boundary zone at the Superstition cauldron coincides regionally with the hypothetical southwesterly continuation of the Jemez Lineament, a prominent northwest-trending zone of Neogene magmatism that extends across New Mexico and eastern Arizona. The turn also coincides with an abrupt change in the dip of the detachment faults that bound the core-complexes in the Basin and Range province. To the west, detachment faults dip to the northeast, and to the south they dip to the southwest. Directly southwest of the Superstition volcanic field the absence of core-complexes is conspicuous.

The nearest core complex, in the South Mountains directly to the west, had a long-lived history (~25-17 Ma) of exhumation involving Tertiary granitoids significantly older than the volcanics of the Superstition volcanic field. Along strike to the southeast from the South Mountains a low-angle, northeast-dipping normal fault in the Santan Mountains, which lie directly southwest of the Superstition volcanic field, is overlapped by a flat-lying outlier of the Apache Leap Tuff.

FINSTICK, SUE A.,

Determining the influence of surface water on Six Mile Spring, Parawan, Utah.

Six Mile Spring has historically been the main source of culinary water for the City of Parowan, Utah, providing about 900 gpm year-round. Routine water sampling indicated a possible link with surface water. Tests were undertaken to determine the influence of surface water on the spring. The results of additional water sampling, as well as the results of a Hydrolab Datasonde 3 logger, a MicroParticulate Analysis (MPA) test, and a calcium chloride tracer test, were inconclusive. A dye tracer test (Fluorescent FWT Red) proved conclusively that Six Mile Spring is under the direct influence of surface water. Geologic mapping indicates that the spring is fault-controlled. However the surface water influence is likely a result of solution channels within the Tertiary (Eocene and Paleocene?) Claron Formation limestone. Future plans call for similar testing on other springs in the area.

HACKER, DAVID B.

Geologic evolution of the Pine Valley Mountains, Basin and Range – Colorado Plateau transition zone, southwest Utah.

Tertiary volcanic and hypabyssal intrusive rocks cover most of the Pine Valley Mountains in Washington and Iron Counties, Utah. The older (Oligocene and Miocene) part of the volcanic sequence consists mostly of regional calc-alkaline ash-flow tuffs derived from caldera sources (Indian Peak and Caliente caldera complexes) outside the area. These volcanic rocks rest on, or are interbedded near the top of, fluvial and lacustrine rocks of the Paleocene-Oligocene Claron Fm. The Claron rests unconformably on fluvial rocks of the Upper Cretaceous Iron Springs Fm. Beginning in the latest Cretaceous and ending in the Paleocene, the Iron Springs and underlying older Mesozoic rocks were folded during the Sevier orogeny, producing a NE-trending open fold, named here the Big Hollow syncline. The axial trend of the syncline is aligned parallel to the Virgin anticline to the east. The Virgin-Big Hollow fold system is interpreted to be younger than thrusting in the Iron Springs district to the north and therefore may represent the youngest structural feature of the orogenic belt in this part of southwest Utah.

During the early Miocene (22 to 20 Ma), an episode of igneous activity in the Pine Valley Mountains produced a series of shallow, calc-alkaline laccolithic intrusions with associated volcanics and gravity-slide structures. The intrusions of the Pine Valley Mountains are part of the larger (140 km long) NE-trending Iron Axis magmatic province, which includes more than a dozen-exposed intrusions consisting mostly of quartz monzonite. The gigantic 30 km long by 11 km wide Pine Valley laccolith (20.5 Ma) caps a large portion of the Pine Valley Mountains and has a remaining thickness of as much as 900 meters. The laccolith intruded beneath a thin cover (<200m of Claron and Tertiary volcanics) and most likely occupied an area of 600+km2, as delineated by erosional outliers to the south and subsurface extensions beneath domed country rocks to the north. Gravity-slide structures associated with intrusive doming of several laccoliths consist of allochthonous masses of brecciated Tertiary volcanic and sedimentary strata detached along low-angle faults from the growing uplifted flanks of the Pinto Peak, Stoddard Mountain, and Pine Valley intrusions as well as the Bull Valley-Big Mountain (BV-BM) intrusion to the west. The largest slide mass (from BV-BM) covers 170 km2, is as much as 670 m thick, and extends more than 20 km from its intrusive arch. Immediately following each sliding episode, each intrusion erupted ash flows and (or) lava flows that partially or totally covered the slide masses. Thus, the laccoliths of the Pine Valley Mountains each show continuous growth stages from (1) initial rapid sill emplacement to its full lateral extent within the Iron Springs or Claron Fms, (2) vertical growth and bending of the overburden as the sill thickened into a laccolith, (3) gravity sliding from the upturned roof as the intrusion continued its vertical growth, and (4) eruption of ash flows and (or) lava flows as a result of pressure release due to gravity sliding.

Following intrusive activity (post-20 Ma), the area again received regional ash-flow deposits from the Caliente caldera complex (Racer Canyon Tuff) followed by local bimodal magmatism that produced abundant basalt lava flows and minor dacitic domes. Numerous post-8 Ma NS-trending high-angle normal faults produced an overall extensional related fragmentation of the Pine Valley Mountains at this time related to Basin and Range tectonism. The location and alignment of the youngest volcanic centers are highly controlled by the presence of these faults.

HARRIS, R., NELSON, S., DORIAS, M., KOWALIS, B., HARRIS, D., AND HEIZLER, M.

Tectonic evolution of the northern-most basement of the Colorado Plateau: Petrology and Thermochronology of the Santaquin metamorphic complex, southern Wasatch Range, Utah.