GEOLOGIC MAP OF THE HOT SPRINGS PEAK QUADRANGLE AND THE SOUTHEASTERN PART OF THE LITTLE POVERTY QUADRANGLE, NEVADA

A. Elizabeth Jones

1997

Scale 1:24,000

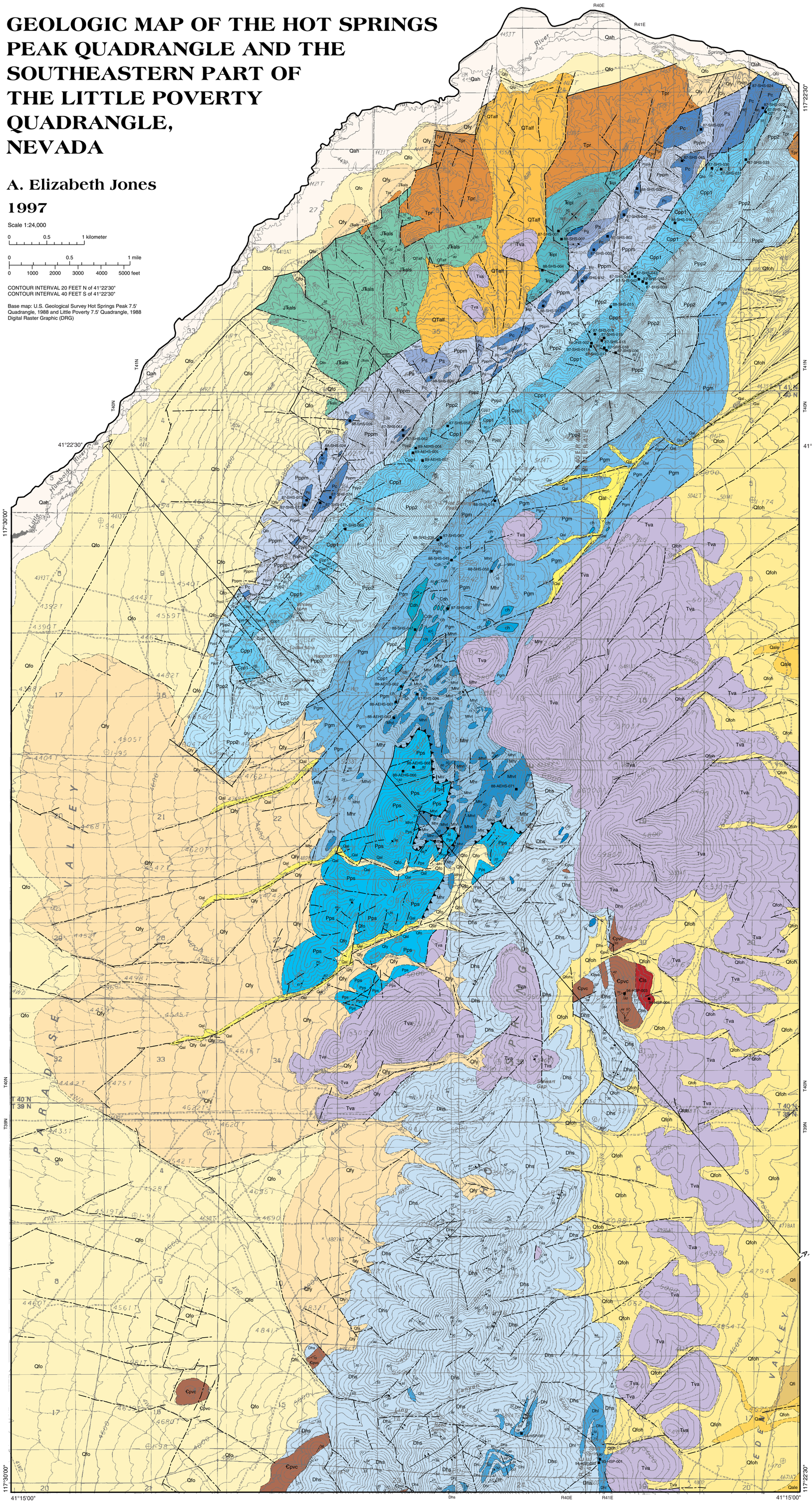
0 0.5 1 kilometer

0 0.5 1 mile

0 1000 2000 3000 4000 5000 feet

CONTOUR INTERVAL 20 FEET N of 41°22'30"
CONTOUR INTERVAL 40 FEET S of 41°22'30"

Base map: U.S. Geological Survey Hot Springs Peak 7.5' Quadrangle, 1988 and Little Poverty 7.5' Quadrangle, 1988 Digital Raster Graphic (DRG)



CENOZOIC ROCKS

Qah **Little Humboldt River stream sediments (Quaternary)** Sand and silt deposits from the Little Humboldt River, northwestern side of Hot Springs Range.

Qal **Channel deposits (Quaternary)** Unconsolidated alluvium in active channels of alluvial fans and within highlands. Composed of silt, poorly sorted sand and cobble-size clasts.

Qale **Alluvium of Eden Creek (Quaternary)** Active alluvium and alluvial fans of Eden Creek, Eden Valley, east side of the Hot Springs Range.

Qfy **Younger alluvial fan deposits (Quaternary)** Unconsolidated fluvial and debris-flow deposits of modern alluvial fans draining westward off the west side of the Hot Springs Range. Composed of poorly sorted sand, silt, and gravel.

Qfi **Intermediate alluvial fan deposits (Quaternary)** Unconsolidated fluvial and debris flow deposits on the east side of the Hot Springs Range. These deposits are older and more incised than the alluvium of Eden Creek (Qale), but less incised than the older alluvial fan deposits (Qfoh) flowing east off the east side of the Hot Springs Range.

Qfo **Older alluvial fan deposits (Quaternary)** Unconsolidated fluvial and debris-flow deposits of older alluvial fans draining westward off the west side of the Hot Springs Range. Composed of poorly sorted sand, silt, and gravel. Moderately incised upper surface. Not necessarily contemporaneous with older alluvial fan deposits (Qfoh) on the east side of the Hot Springs Range in Eden Valley.

Qfoh **Older alluvial fan deposits, east side Hot Springs Range (Quaternary)** Unconsolidated fluvial and debris-flow deposits of older alluvial fans draining eastward off the east side of the Hot Springs Range. Composed of poorly sorted sand, silt, and gravel. Moderately incised upper surface. Not necessarily contemporaneous with older alluvial fan deposits (Qfo) on the west side of the Hot Springs Range in Paradise Valley, or the older alluvial fan deposits on the west side of the Osgood Mountains in Eden Valley (Qfoo) in the Delvada Spring Quadrangle to the south. The nearest age data for alluvium comes from the valley east of Eden Valley on the east side of the Osgood Mountains. Fission-track dating of zircons from volcanic ash in channel lenses 30 m down in alluvium above the Rabbit Creek gold deposit gave ages of 2.8±0.8 Ma and 2.7±1.0 Ma (Madden-McGuire and others, 1991b).

QTalf **Alluvial fan (Quaternary or Tertiary)** Unconsolidated to semi-consolidated fluvial and debris-flow deposits of older alluvial fans. Composed of poorly sorted sand, silt, and gravel. Deeply incised indicating uplift from Quaternary tectonic activity.

Tpr **Porphyritic rhyolite (Tertiary)** Exposed only at the far northern edge of the Hot Springs Range.

Tva **Vesicular basaltic andesite (early Miocene)** Vesicular aphanitic basaltic andesite is black with a fine sugary texture on a fresh surface, and weathers to reddish brown. Elongate 1-2 cm pipe vesicles are common at certain horizons. Weathered casts of hornblende needles are visible at some horizons. Red to black volcanic clasts define a breccia horizon interpreted to represent the base of a flow layer intermittently exposed across the area. This unit has steeply east-dipping foliations at several localities on the east side of the range, and foliation that dips gently west on the west side of the range. Some of these dips may represent structural fabric imposed on the rock. Although the massive character and poor exposure of this unit prevent observation of many compaction foliation measurements that would indicate a primary dip, the contact between the volcanic rocks and the underlying Harmony Formation follows a map trace indicating a gentle eastward or southeastward dip of the volcanic unit that is exposed south of this quadrangle near Willow Creek. This unit correlates with Hotz and Willden's (1964) unit Tva in the Osgood Mountains Quadrangle. Erickson and Marsh (1974) identified this unit (Ta) as 22.0±0.7 Ma based on whole-rock K-Ar analysis by M.L. Silberman in the Golconda Quadrangle to the south.

MESOZOIC ROCKS

Jungo terrane

JTrals **Auld Lang Syne Group (Middle Triassic through Jurassic)** Micaceous and quartz-rich sandstone, siltstone, and shale characterize this poorly exposed unit at the northwestern edge of the Hot Springs Range. No age data have been obtained from this unit. It is tightly folded and cleaved with east northeast striking bedding and foliations that are oblique to those in the Poverty Peak terrane. The contact between the Auld Lang Syne Group and the Poverty Peak melange is not exposed. A thick wedge of older Quaternary or Tertiary alluvium separates the Auld Lang Syne Group from the Triassic Little Poverty limestone, obscuring the contact between them. This unit is inferred to correlate with the extensively exposed Triassic to Jurassic Auld Lang Syne Group in the Santa Rosa Range immediately northwest of the Hot Springs Range (Compton, 1960; Burke and Silberling, 1973). It is shown on the cross section on the upper plate of a west dipping structure that emplaces it over rocks of the Golconda terrane. This structure is interpreted to correlate with the Fencemaker fault of Oldow (1984).

TrIpl **Limestone of Little Poverty (Triassic)** This limestone varies lithologically from fine brown laminated shale interbedded with limestone to fossiliferous oolitic micrite and coarser sparite. Late Triassic (Karnian-Norian) conodonts and echinoid spines confirm the early Mesozoic age for this unit (table 1). Structures are difficult to discern in the massive limestone beds of this unit, but the strongly cleaved interlayered shale horizons suggest that it is folded. It lies structurally above serpentine, gabbro, and basalt of the Poverty Peak melange along the Fencemaker fault of Oldow (1984).

PALEOZOIC ROCKS

Golconda terrane

The Golconda terrane in the Hot Springs Range has been subdivided into units and subunits. These units are grouped together and referred to as the Golconda terrane because they share many structural, age, and lithologic characteristics with rocks that are included in the Golconda terrane elsewhere in northern Nevada. The Golconda terrane contains two melange units in the Hot Springs Range which are structurally interleaved between the subterranes. Both of these melange units contain blocks of many different rocks, some of which correlate with other subunits of the Golconda terrane.

Pgm / ch **Golconda melange (Permian)** This probable Permian unit is emplaced between the Home Ranch and Poverty Peak subterranes. Although the melange is a disrupted, heterogeneous unit, it does have mappable lithologic horizons. Large blocks in the sheared basaltic tuff and argillite matrix include pillow basalt, red ribbon chert, interbedded chert and sandstone, calcareous siltstone, and massive limestone and volcanic breccia. Lithologic and biostratigraphic data link many of these blocks to adjacent terranes in the Hot Springs Range and the Osgood Mountains. One Early Mississippian block is the same age and lithology as the adjacent Home Ranch subterrane. A dismembered string of radiolarian-bearing Osagean (Early Mississippian) chert and sandstone blocks resembling the Dry Hills subterrane (Cdh) in the Osgood Mountains (Jones, 1991b; Jones and Jones, 1991) trends northeast through the melange, parallel to its boundaries. A second belt of tuffaceous matrix with interlayered wisps of limestone trends subparallel to the chert block stringers. Two other chert blocks in the melange (ch) contain Carboniferous radiolarians. Black chert beds in an olive basaltic matrix at the southern boundary of the melange contain middle to late Leonardian conodonts, and constrain the maximum age for the Golconda melange to late Early Permian. The samples with radiolarians and conodonts are listed in table 1. The biostratigraphic data across the boundaries between the Golconda melange and adjacent units indicate that the contacts between them must be structural.

Pppm / Ps / Pg / Pc **Poverty Peak melange (Permian)** The Poverty Peak melange, exposed at the northwest edge of the Hot Springs Range, has a fabric similar to the Golconda melange, but its block composition is somewhat different. It is composed of large blocks of altered serpentine (Ps), gabbro (Pg), basalt breccia and red radiolarian chert (Pc) in a tuffaceous basalt matrix. All of the radiolarian ages from chert blocks in the Poverty Peak melange are Early Permian. Chert samples with radiolarians collected from these quadrangles are listed in table 1. The blocks of chert and serpentine trend northeasterly, subparallel to the boundaries of the melange. Poor exposure prevents an accurate assessment of the size, extent, and continuity of most blocks.

PCpp **Poverty Peak subterrane (Permian and Carboniferous)** The Poverty Peak subterrane is divided into two units based on lithologic and age characteristics, Poverty Peak I (Cpp1) and Poverty Peak II (Ppp2). The contact between Poverty Peak I and Poverty Peak II is interpreted to be depositional. Chert beds of Poverty Peak I are folded in an anticlinal sequence that is oldest in the middle and youngs outward to the southeast and northwest. This is best displayed by the age data in the Little Poverty Quadrangle shown in table 1. Rare volcaniclastic and chert horizons at the base of Poverty Peak II indicate interlayering of Poverty Peak I and II rocks. Locally, beds of bleached chert and shale are tightly folded with siltstone and quartz arenite along the folded contact. On a regional scale, the contact is a continuous northeast-striking, steeply dipping horizon. The contacts between the Poverty Peak subterrane and the Poverty Peak melange to the north and the Golconda melange to the south are not well exposed, and are inferred to be faults.

Cpp1 **Poverty Peak I (Carboniferous)** A sequence of bedded red and green radiolarian chert, massive and pillowed basalt, and basaltic volcaniclastic rocks. Radiolarian ages from the bedded cherts range from Middle Mississippian through Pennsylvanian or possibly earliest Permian. The samples are listed in table 1. Radiolarian chert in Poverty Peak I is older than the chert in the Poverty Peak melange.

Ppp2 **Poverty Peak II (Permian)** Interbedded calcarenite, quartz arenite, siltstone, and shale. Nerites-type worm tracks are common. A single early Leonardian (middle Early Permian) conodont sample of calcarenite, dated by Anita Harris and Bruce Wardlaw (U.S. Geological Survey) and listed in table 1, is the only age constraint for this unit. The sample is from the Little Poverty Quadrangle.

Cdh **Dry Hills subterrane** This unit occurs only as large blocks and stringers in the Golconda melange (see above). The blocks consist of interbeds of feldspathic sandstone and Carboniferous green, black, and gray radiolarian chert. Three of the blocks in the Hot Springs Peak Quadrangle contained early Mississippian radiolarians. The samples are listed in table 1. The Dry Hills subterrane is extensively exposed in the Eden Valley Quadrangle in the adjacent Osgood Mountains to the east (Jones, 1991b; Jones and Jones, 1991) where it was originally mapped as the Farrel Canyon Formation by Hotz and Willden (1964).

Mhr / Mhrl **Home Ranch subterrane (Mississippian)** This unit consists of two rock types, Mhr, mafic-andesitic volcanics and Mhrl, massive limestone and dark-gray chert. Massive, bedded fossiliferous limestone, limestone and basalt conglomerate, spiculitic dark-gray and black chert, volcanic breccia and debris flows, and massive pillowed basalt are the important rock types of the Home Ranch subterrane exposed in both the northern Hot Springs Range and the adjacent Osgood Mountains to the east. Crystal-rich basalt sandstone layers 5 to 15 cm thick are interbedded with laminated, cherty, black tuff. Graded beds containing broken plagioclase and perthite phenocrysts and altered volcanic (basalt?) clasts show soft-sediment slumping and bed offsets. Clast-supported volcaniclastic sandstones and breccias have clasts of chert, argillite, basalt, and rare quartz siltstone. Conglomeratic layers have rounded to subrounded clasts of basalt, argillite, and chert 10 to 20 cm in diameter. Bioclastic limestone beds tens of meters thick are interbedded with basalt flows. Matrix-supported, graded carbonate conglomerates have fragments of pillow basalt and vesicular flows in a limestone matrix. Olistostromal debris-flow deposits containing large blocks of fossiliferous limestone and basalt are the most chaotic unit within the Home Ranch subterrane. Lithologic characteristics of this unit are illustrated in Jones (1991b). Two limestone samples dated by Anita Harris (U.S. Geological Survey) contain Early Mississippian (late Kinderhookian-Osagean) conodonts from this subterrane. They are listed in table 1. An extensive carbonate bed with well-preserved, in-place Mississippian bryozoans demonstrates that some of the carbonate beds are not reworked. The Home Ranch terrane is faulted to the north against the Golconda melange, and faulted on a low angle structure over the Permian phyllite and shale to the south. This is the same rock unit that is mapped as the Goughs Canyon Formation by Hotz and Willden (1964) in the Osgood Mountains.

Pps **Phyllite and shale (Permian)** This unit consists of strongly cleaved, foliated phyllite and shale with blocks of limestone and beds and blocks of silty chert. A few coarse feldspar-rich sandstone beds are folded in with the shale. These coarser beds have dark-gray quartzite and black chert clasts. Reddish-brown to green shale commonly has abundant Nerites-type worm tracks, similar to those found in the Poverty Peak II subterrane. Latest Leonardian conodonts (late Early Permian) were extracted from a fine-grained mottled dark-gray micrite block. Mississippian radiolarians were found in a black cherty siltstone lense, indicating that olistostromal or reworked chert blocks may be a component of this unit. The samples and their faunas are listed in table 1. The microfossils indicate a maximum age of late Early Permian for this unit. A poorly exposed northeast-trending unit in the low hills at the center of the quadrangle is characterized by float of scattered gray quartzite cobbles and small boulders. Some blocks consist of fist-size quartzite cobbles in a siliceous matrix. A single outcrop adjacent to the Harmony Formation is a sandy limestone with 20 to 40 cm rounded quartzite and crinoid-bearing limestone cobbles. The exposure may be part of the Late Devonian Harmony Formation and not part of this unit. This unit lies structurally below the Home Ranch subterrane on a low-angle structure that is broken in several places by Quaternary faults, and above the Harmony Formation. It is unclear whether this rock unit is part of the Golconda terrane or if it represents a separate tectonic package. Willden (1964) originally mapped this unit as part of the Auld Lang Syne Group, inferring a Jurassic age. While the Permian biostratigraphic data collected in this study does not preclude a Jurassic age, it is reinterpreted here to be a Permian unit questionably related to the Golconda terrane.

Dutch Flat terrane

The Dutch Flat terrane is composed of three rock units, the Cambrian Paradise Valley Chert, a Cambrian limestone, and the Late Devonian Harmony Formation. They are grouped together into a single terrane because: a) they have historically been interpreted as depositionally related, b) they have similar structural characteristics, and c) they are known to be structurally separate from other Paleozoic rocks in this quadrangle and throughout the region.

Dh **Harmony Formation (Late Devonian)** The southern half of the Hot Springs Peak Quadrangle is underlain by coarse graded beds of turbiditic arkosic sandstone, siltstone, and shale of the Harmony Formation. Two members of the Harmony Formation are recognized: Dhs, a feldspathic sandstone member; and Dhl, a turbiditic limestone member.

The age of the Harmony Formation has been controversial. It was originally tentatively assigned a Mississippian age, based on an interpreted depositional relationship with inferred Mississippian rocks at Battle Mountain (Ferguson and others, 1952). The age was later revised to Late Cambrian based on three Late Cambrian fossil localities in the Hot Spring Range and one locality in the Osgood Mountains (Hotz and Willden, 1964). Late Cambrian trilobites were found in "discontinuous limestone beds or lenses" associated with blocks of the Harmony Formation in "sheared shale and sandstone" in Goughs Canyon in the Osgood Mountains (Hotz and Willden, 1964). Late Cambrian fossils were also extracted from limestone interpreted to be part of the Harmony Formation at the northern end of the Hot Springs Range in the Hot Springs Peak Quadrangle (Palmer, in Hotz and Willden. 1964). Late Cambrian fossils were also discovered in two locations in the Paradise Valley Chert which has usually been interpreted to be depositional beneath the Harmony Formation (Hotz and Willden, 1964). More recently, Late Cambrian to Early Ordovician acritarchs were identified at the type locality of the Harmony Formation in Klurcy Canyon in the northern Sonoma Range (Madden-McGuire and others, 1991a), but these results were later demonstrated to be unreliable (D.J. Madden-McGuire, pers. commun., 1994). Recently it has also been recognized that the Cambrian age from the Osgood Mountains used to date the Harmony was derived from fossils in a limestone block in a large melange unit that contains fossils as young as Pennsylvanian in age (Jones, 1991b; McCollum and McCollum, 1991). Thus, the unit in the Osgood Mountains referred to as "Harmony Formation" is actually a heterogeneous, disrupted structural unit that contains, among other things, blocks of Cambrian limestone, and blocks of feldspathic sandstone identical to the Harmony Formation.

Preliminary results from two limestone samples collected at the northeast edge of the Delvada Spring Quadrangle (Jones, 1997) indicate that the turbiditic limestone interbedded with the sandstone of the Harmony Formation is Late Devonian in age (J.E. Repetski, pers. commun., 1994). The results are reported in table 1. In this case, the limestone is clearly interbedded with the bedded feldspathic sandstone. These massive beds are not part of a melange unit with discontinuous blocks, as in the Osgood Mountains and parts of the Sonoma Range, but rather they form continuous beds that extend for significant distances across the range. Unlike the limestone locality at the north end of the Hot Springs Range, the relation of the limestone horizon to the feldspathic sandstone is clearly depositional. Further sampling to confirm this age is in progress. The relation between the Cambrian ages assigned to the Paradise Valley Chert and the Harmony Formation remains unknown. Because of the turbiditic nature of the limestone, this age can only be taken as a maximum age constraint. The Harmony Formation could be younger, but it cannot be older than Late Devonian. The nearest rock unit of similar age and lithology is in the Osgood Mountains on the east side of Eden Valley. There, earliest Mississippian radiolarian-bearing chert of the Dry Hills subterrane (Jones, 1991b), the Farrel Canyon Formation of Hotz and Willden (1964), is interbedded with a feldspathic sandstone compositionally nearly identical to the Harmony Formation.

Dhs / ls **Harmony Formation, sandstone member** Graded beds of turbiditic arkosic sandstone grade to finer siltstone and olive-brown and hematite-red shale. Large (1-3 mm) quartz and feldspar clasts are common in the coarser beds. The sandstone is clast supported with 80-90% quartz grains and 5% white feldspar fragments. It has as much as 10% matrix in places. Limestone outcrops of unknown age are shown by ls. Where beds are clearly graded, facing directions indicate that the beds are folded with a westward vergence along generally northeast-trending, shallowly plunging fold axes. Detailed lithologic descriptions of this unit have been provided by Hotz and Willden (1964) and Rowell and others (1979).

Dhl **Harmony Formation, limestone member** Graded sandy limestone is interbedded with the Harmony sandstone in a northeast-trending zone that runs across most of the length of the range. The northern extent of this zone reaches into the southern part of the Hot Springs Peak Quadrangle. The beds appear discontinuous on the map because of the complex folding of the formation, as well as the intertonguing of the two units. Individual beds, however, can be followed for tens of meters, and seen to be interlayered with feldspathic sandstone. Two-meter-thick beds contain as much as 40% 1- to 2-mm well-rounded quartz grains, white lithic fragments, and black chitinous fragments. Finer grained layers have crossbeds, ripples, and laminae.

Cpvc **Paradise Valley Chert (Late Cambrian)** Dark-green to black beds of the Paradise Valley Chert are folded together with the Harmony Formation in the east-central and southwest regions of the quadrangle. The dark chert is opaque, and is often characterized by cloudy lenses and spots of limonite and hematite within the 5- to 20-cm-thick beds. Hotz and Willden (1964) recovered Late Cambrian trilobites from shaly limestone horizons within the Paradise Valley Chert at two locations in the Hot Springs Range. Finely laminated and foliated, red, black, green and light-brown shales are common near the contact with the Harmony Formation. The contact between the Paradise Valley Chert and the Harmony Formation has always been interpreted as depositional. Structural evidence presented here supports the interpretation that it is at least conformable. The presence of Late Devonian fossils clearly interbedded with the feldspathic sandstone of the Harmony Formation, however, calls into question the depositional contact between the Harmony Formation and the Paradise Valley Chert. This raises the possibility that the contact may be a structure. For the contact to be depositional, there would likely be a major disconformity between the two units. Alternatively, the fossils that have been recovered from the Paradise Valley Chert could be reworked and thus not representative of the true age of the formation.

Cls **Limestone (Late Cambrian)** Fossiliferous, fine-grained, micritic limestone. Cambrian fossils were found by Hotz and Willden (1964) and in this study (see table 1) in this rock unit. This limestone does not crop out, but is represented by poorly exposed float across the hillside. The lithologic characteristics of the Cambrian limestone are very distinct from the characteristics of the Late Devonian turbiditic limestone interbedded with the Harmony Formation. There is no question they represent different rock units. While this limestone is close to exposures of both the Harmony Formation and the Paradise Valley Chert, there is no demonstrable stratigraphic relation between the Cambrian limestone and either the Paradise Valley Chert or the Harmony Formation in these quadrangles. The Cambrian limestone may be part of a melange unit, similar to that exposed in the Osgood Mountains to the east, which also contains blocks of exotic Cambrian limestone. It may also be related to the Paradise Valley Chert which Hotz and Willden (1964) reported to contain Cambrian fossils in the Delvada Spring Quadrangle to the south.

See accompanying text for references, age data table, and a discussion of the geology of the map area.

Contact Dashed where approximately located.

High-angle fault Solid where known, dashed where approximately located, dotted where concealed.

Low-angle fault Dashed where approximately located, sawteeth on upper plate.

Lineament Determined from aerial photographs.

Anticline Showing trace of axial surface and plunge.

Overturned Anticline Showing trace of axial surface, direction of dip of limbs, and plunge.

Overturned Syncline Showing trace of axial surface, direction of dip of limbs.

Strike and dip of bedding

55 Inclined, facing direction unknown — 90 Vertical — 81 Overturned

79 Inclined, facing upright — 90 Vertical, showing top

Strike and dip of foliation

39 Inclined — Vertical 90

Sample location for biostratigraphic dating.

87-SHS-93

Quaternary: Qah, Qal, Qfy, Qale, Qfi, Qfo, Qfoh, QTalf
Tertiary: Tpr, Tva
Jurassic Triassic: *Jungo terrane* JTrals, TrIpl
Permian Carboniferous: *Golconda terrane* Pppm, Ps, Pg, Pc, PCpp, Ppp2, Cpp1, Pgm, Cdh, Pps, Mhr, Mhrl
Devonian: *Dutch Flat terrane* Dh, Dhs, Dhl
contact type unknown Cpvc
contact type unknown Cls
Cambrian

Field work done in 1987–1991, 1996.

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