## 2.2 APPLICATION OF METHODS

This section briefly presents results of the application of the methods described in section 2.1 to the study of the calcite-silica deposits in Trench 14 and the sand ramps on Busted Butte. Section 2.3 provides additional detail, primarily for the specialist, for most of these applications. In several of the subsections below references are given to tables. The locations of samples taken from Trench 14 and given in the tables are shown in Appendix D. Coordinate locations for samples taken from Trench 14 are included with sample descriptions in Tables A-3, A-4, A-15, and B-10.

### 2.2.1 Field Data

Characteristics of calcite-silica deposits that aid in distinguishing pedogenic from spring deposits include the following: 1) In pedogenic deposits $CaCO_3$ enriched zones form parallel with slopes as contrasted with distinct mounds for springs (Bachman and Machette, 1977). Because the carbonate enriched horizons can be traced upslope past the vein fillings, the slope parallel deposits cannot be interpreted as a draped mound formed by springs. 2) The geometry of vein deposits underlying springs (best known from economic mineral deposits) tend to have sub-parallel walls that extend tens to hundreds of meters deep (e.g. Sawkins, 1984). See Figure 5. An example is the Santo Niño vein, Zacatecas, Mexico (Figure 6). This vein appears to be represented at the surface by a stockwork of small quartz-calcite veins, but at depth the vein ranges from 0.1 to >3 m wide (Gemmell et al., 1988). This splitting up of a major vein at depth over a vertical range of hundreds of meters into smaller ones closer to the surface contrasts with the relations found at Trench 14. Simmons et al., (1988) estimate the paleosurface when the veins formed as being 100 m above the present surface, and draw parallels between relations found for the Santo Niño vein to those at the active hydrothermal system at Broadlands, New Zealand. For both Santo Niño and Broadlands the evidence indicates that hydrothermal systems have been driven by the cooling of magma at depth following the eruption of welded tuffs. Additional examples of similar veins could be cited, but this would digress from the topic of this report. Extensive exposures along Furnace Creek, California (Figure 7) also exhibit sub-parallel walls in veins underlying a spring deposit (Winograd et al., 1985). In contrast veins formed pedogenically as fillings of fractures or faults should pinch out rapidly with depth (Gile et al., 1966) as a consequence of the narrowing of the apertures of the fractures and faults that were opened by various erosional and weathering phenomena, such as soil creep. 3) Detrital matter, as for example black volcanic ash, can easily become incorporated into pedogenic deposits, but is likely to be washed out from actively flowing springs. 4) In a spring deposit suspended mineral particles precipitated from solution would ordinarily be carried upward through the feeder vein or conduit, but often settle out within the pool of the spring. Consequently, textural relations will differ for spring deposits between the vein filling and horizontal deposits. The contrasts between the characteristics of pedogenic and spring deposits, rather than the characteristics themselves, constitute the criteria and are generic rather than site specific.

In respect to all these criteria the actual field evidence favors a pedogenic origin.

ENCLOSURE 1

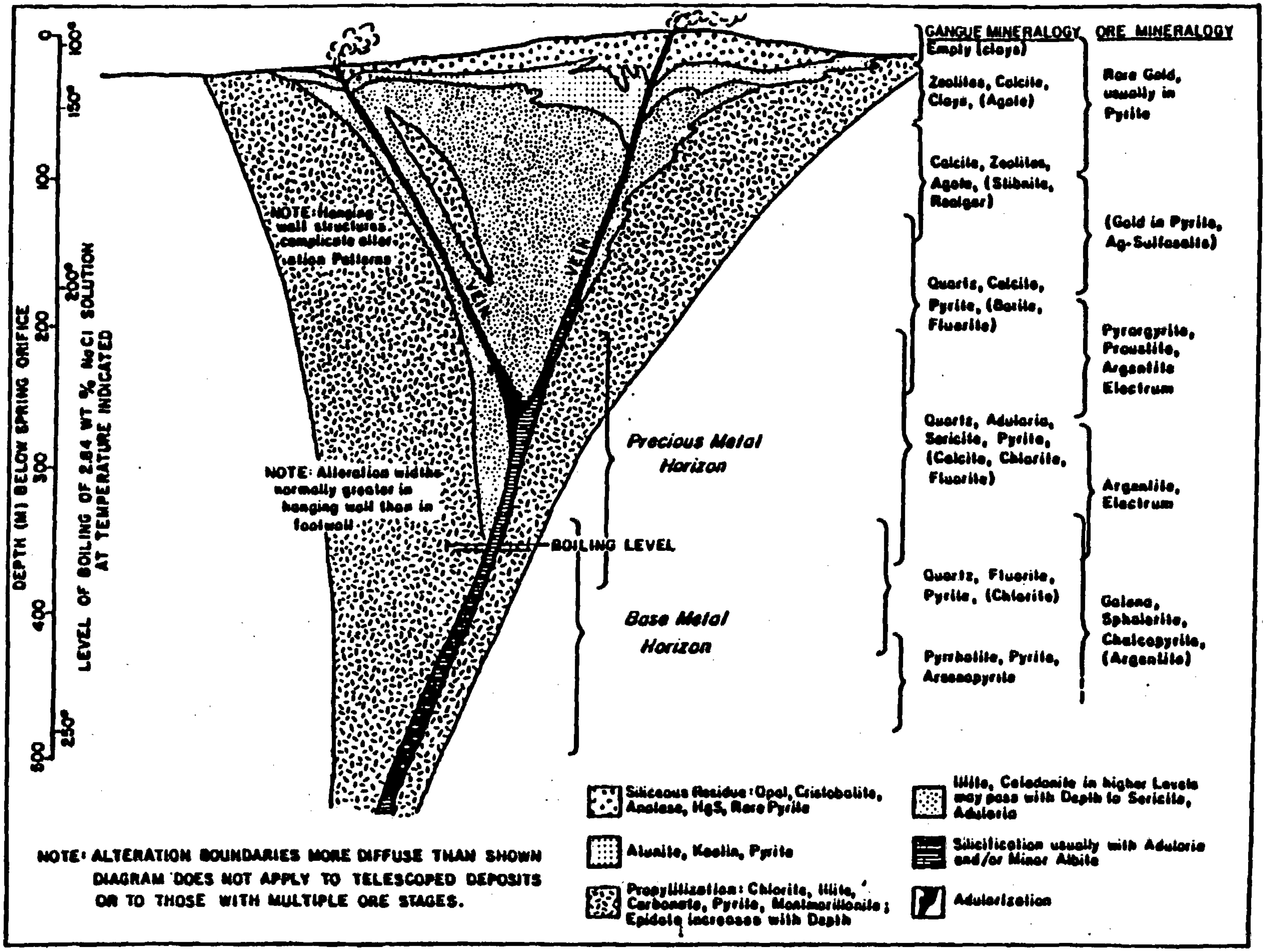

*Figure 5. Idealized model for an epithermal precious metal vein system incorporating many of the features found in such systems. In any one system only some of features shown are manifest; for example, not all epithermal precious metal deposits pass downwards into base metal veins (from Sawkins, 1984).*

Vaniman, D. T.; D. L. Bish and S. Chipera, 1988. "A Preliminary Comparison of Mineral Deposits in Faults Near Yucca Mountain, Nevada, with Possible Analogs," Los Alamos National Laboratory Report LA-11289-MS, Los Alamos, New Mexico, 54p. (NNA.870521.0027)

Vaniman, D. T.; M. H. Ebinger; D. L. Bish and S. J. Chipera, 1992. "Precipitation of Calcite, Dolomite, Sepiolite and Silica from Evaporated Carbonate and Tuffaceous Waters of Southern Nevada, USA, Water-Rock Interaction," Proceedings of the 7th International Symposium on Water-Rock Interaction - WRI-7/Park City/Utah/USA/13-18 July 1992, Y. K. Kharaka and A. S. Maest, eds., Rotterdam, Balkema, p. 687-691. (NNA.921019.0160)

Viles, H. A. and A. S. Goudie, 1990. "Reconnaissance Studies of the Tufa Deposits of the Napier Range, N.W. Australia," Earth Surface Processes and Landforms, Vol. 15, p. 425-443. (NNA.921019.0169)

Waddell, R. K; J. H. Robison and R. K. Blankennagel, 1984. "Hydrology of Yucca Mountain and Vicinity, Nevada-California Investigative Results Through Mid-1983," U.S. Geological Survey Water-Resources Investigations Report 84-4267, U.S. Geological Survey, Denver, Colorado, 72p. (NNA.900618.0074)

Wagner, G. A.; G. M. Reimer; B. S. Carpenter; H. Faul; R. Van der Linden and R. Gijbels, 1975. "The Spontaneous Fission Rate of U-238 and Fission Track Dating," Geochimica et Cosmochimica Acta, Vol. 39, p. 1279-1286. (NNA.921019.0188)

Watts, N. L., 1980. "Quaternary Pedogenic Calcretes from the Kalahari (Southern Africa): Mineralogy, Genesis and Diagenesis," Sedimentology, Vol. 27, p. 661-686. (NNA.921019.0175)

Whelan, J. F. and J. S. Stuckless, 1990. "Reconnaissance $\delta^{13}$C and $\delta^{18}$O Data From Trench 14, Busted Butte, and Drill Hole G-4, Yucca Mountain, Nevada Test Site," Proceedings of the International Topical Meeting on High Level Radioactive Waste Management, Las Vegas, Nevada, April 8-12, 1990, Vol. 2, p. 930-933, Copyright 1990 by the American Nuclear Society, La Grange Park, Illinois, and American Society of Civil Engineers, New York, New York. (NNA.900523.0228)

White, D. E.; W. W. Brannock and K. J. Murata, 1956. "Silica in Hot-Spring Waters," Geochimica et Cosmochimica Acta, Vol. 10, p. 27-59. (NNA.921019.0168)

ENCLOSURE 2

Winograd, I. J. and W. Thordarson, 1975. "Hydrogeologic and Hydrochemical Framework, South-Central Great Basin, Nevada-California, with Special Reference to the Nevada Test Site," U.S. Geological Survey Professional Paper 712-C, U.S. Geological Survey, Denver, Colorado, 126p. (NNA.870406.0201)

Winograd, I. J.; B. J. Szabo; T. B. Coplen; A. C. Riggs and P. T. Kolesar, 1985. "Two-Million-Year Record of Deuterium Depletion in Great Basin Ground Waters," Science, Vol. 227, p. 519-522, © AAAS. (NNA.870407.0405)

Winograd, I. J.; B. J. Szabo; T. B. Coplen and A. C. Riggs, 1988. "A 250,000-year Climatic Record from Great Basin Vein Calcite Implications for Milankovich Theory," Science, Vol. 142, p. 1275-1280, © AAAS. (NNA.910522.0030)

Wright, V. P., 1986. "The Role of Fungal Biomineralization in the Formation of Early Carboniferous Soil Fabrics," Sedimentology, Vol. 33, p. 831-838. (NNA.921019.0173)

Wright, V. P., 1989. "Terrestrial Stromatolities and Laminar Calcretes," Sedimentary Geology, Vol. 65, p. 1-13. (NNA.921019.0172)

## REGULATIONS

NWPA, 1983. Nuclear Waste Policy Act of 1982, Public Law 97-425, 42 CHI 10101-10226, Washington, D.C., January 7, 1983.

NWPAA, 1987. Nuclear Waste Policy Act Amendments, Amendments to the Nuclear Waste Policy Act of 1982 - Public Law 100-302 - December 22, 1987, 100th Congress. Title V, Washington, D.C., p. 236-266.