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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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TO: John J. Linehan, Acting Chief, Operations Branch (HLOB)
Division of High-Level Waste Management, M/S 4-H-3

FROM: Paul T. Prestholt, Sr. On-Site Licensing Representative

DATE: August 18, 1988

SUBJECT: EXPLORATORY SHAFT UNDERGROUND GEOLOGIC MAPPING - NNWSI

Please find enclosed the above-referenced memorandum.

PTP:nan
cc: Tom Cardone w/enc.

102
WM-11
NH03

United States Department of the Interior

BUREAU OF RECLAMATION

ENGINEERING AND RESEARCH CENTER

P O BOX 25007
BUILDING 67, DENVER FEDERAL CENTER
DENVER, COLORADO 80225-0007

IN REPLY REFER TO: D-1570

APR 1 3 1988

Memorandum

To : U.S. Geological Survey, Water Resources Division, MS-421, P.O. Box 25046, Denver, Colorado 80225
Attention: Larry Hayes

Through: U.S. Geological Survey, Geologic Division, MS-913 P.O. Box 25046, Denver, Colorado 80225
Attention: Bob Raup

From: Technical Program Officer, NNWSI/USBR (Nevada Nuclear Waste Storage Investigations)

Subject: Exploratory Shaft Underground Geologic Mapping - NNWSI

There is considerable misunderstanding of underground geologic mapping and resultant personnel needs and costs relative to the ESF. Following is a discussion of underground geologic mapping in the NNWSI Exploratory Shaft Facility (ESF). This information would be useful in planning and budgeting activities. Explained are the differences between the mapping requirements at the Underground Research Laboratory (URL) Canada, the basalt site at Hanford, the salt site at Deaf Smith County, and NNWSI needs. Although no active investigations are underway at the basalt or salt sites; they are included for comparison purposes. Discussed are: 1) impacts of geologic mapping on the excavation cycle and 2) when mapping is practicable, both from the geologists' and the contractors' standpoint. Finally, four mapping scenarios are presented that relate directly to the cost of geologic mapping at the ESF.

<u>Underground Research Laboratory, Manitoba, Canada.</u> Rock at the URL consists of unweathered granite. The granite is essentially unfractured, structureless and is literally of tombstone quality. Minor, extremely localized zones of fracturing are present. Because of the massiveness of the rock, the material is impermeable except for small amounts of water on rare fractures. The test areas are located below the water table. There are no

plans to use the URL as a repository; it is strictly a research facility.

Geologic mapping at the URL is done by conventional methods (photomosaic) with a shift per day dedicated to mapping. The excavation is essentially unsupported, unlined, and only one heading is mined at a time.

Hanford, Washington. Rock at the Hanford site consists of interlayered basalt flows and interflow material. The rock is permeable and most of the shaft is below the water table. The potential repository location is in a thick basalt layer below the water table.

The exploratory shaft was to be drilled, with no geologic mapping planned in the shaft.

Deaf Smith County, Texas. Rock at the Deaf Smith site consists of interbedded sediments including a thick salt zone. Some of the rock is permeable and most of the shaft is below the water table. The potential repository location is in bedded salt below the water table.

Geologic mapping plans are unknown; this site is still in the planning stage.

Yucca Mountain, Nevada

Rock at the Yucca Mountain site consists of bedded volcanic tuffs. The rock is highly fractured and permeable with the entire ESF and potential repository located above the water table.

ESF GEOLOGIC MAPPING

The major difference between the sites discussed above and the Exploratory Shaft (ES), is the location of the repository above the water table. Because the permeability of the unsaturated zone above the water table is a key factor in characterizing the site, and fractures are a major path for water movement, extreme detail is necessary when mapping at the ES. Unsaturated zone permeability studies expand the state-of-the-art, and information needs are different than conventional requirements. Extremely detailed fracture mapping in highly fractured rock is a very labor-intensive activity. This need for detail requires either extensive time for conventional mapping or faster, sophisticated mapping methods; we have chosen the latter.

An additional factor is that the shaft will be lined as it is excavated, with a maximum 30 feet of rock exposed at any one time. The drifts will be covered with chain link fabric one round behind the heading. All geologic mapping must be accomplished before lining or chain link is installed.

CONSTRUCTION IMPACTS

The major impact on shaft and drift construction is the amount of time the contractor must stand by while geologic mapping is accomplished. We reduced this time from eight hours (a complete shift) to two hours per round by using photogrammetry. (Note: Prototype testing in G-Tunnel indicates that two hours per round is a practical time estimate.) This two-hours-per-round time requirement will allow mapping up to three 6-foot rounds per shift, i.e. six hours to map three rounds.

Figure 1 depicts the advantages and disadvantages of geologic mapping during or between each phase of the excavation cycle. Mapping is possible between several phases of the excavation cycle as shown in Figure 1a. However, because of the reasons shown in Figure 1b, mapping during all but one interim period between excavation cycle phases is impractical. We rated each mapping window from the standpoints of the contractor and the USBR/USGS (with no. 1 being the most preferred). Figure 1a shows close agreement between the preferences of the contractor and those of the mappers. The preferred window, between support and lining, is the most advantageous from the geologists' and the contractors' standpoint.

Several scenarios have been studied to evaluate data collection and its relationship to construction costs and personnel needs. Figure 2 shows the staff required to conventionally map the ESF on a three-shift-per-day, seven-day-per-week work schedule. This organization and cost is included for reference because conventional mapping is or probably would be the mapping method used at the other sites. For comparisons, an average cost of $80,000 per person has been assumed. This cost per person is the average cost based on the estimates for FY 1992. Cost for conventional mapping is approximately $2,560,000 during maximum effort by the contractor. Figures 3 through 5 show the three practicable scenarios for mapping at the ESF using photogrammetry; these are discussed below:

Figure 3 shows the organization necessary to map the ES as presently planned (using photogrammetry). This plan, as formulated through discussions with the Waste Management Projects Office and REECo, assumes that personnel will be available to map the shafts and drifts at any time during three shifts per day, seven days a week. This scheme allows maximum flexibility for the contractor. The number of active headings contributes significantly to the number of mapping staff. Whether 1, 2, or 3 six-foot rounds are mapped at a time does not impact the number of personnel required for mapping. When not actually underground mapping, these personnel will process data, maps, samples, and support other experiments. Mapping logistics also require time for equipment maintenance, preparation, and travel to and from the mapping sites. Cost for mapping is approximately $1,920,000 during maximum effort by the contractor.

Figures 4 and 5 present organizations for mapping during one or two shifts per day, respectively. These assume that contractor activity will be restricted with mapping done only on shifts covered by geologic mapping teams, i.e. day shift. Because mapping is practical only between the support and lining phases, the contractor is severely restricted. Even though the one- and two-shift mapping scenarios show costs of $1,200,000 and $1,680,000 respectively as compared to $1,920,000 for the planned three-shift-per-day scheme, overall project costs will be higher due to restrictions on the contractor. If the contractor has placed support and a mapping team is not available, he must delay operations or do maintenance until a team is available. This time can exceed two complete shifts. Assuming the contractor loses an average of a shift per day, or assumes this loss in his bid or schedule, then the cost and the time required to excavate the shaft and drifts increases accordingly. Also, total mapping costs increase because the number of staff required per year remains high due to the longer duration of maximum contractor effort. The increase in cost and time (up to one year longer) for construction could easily offset the cost of having mapping teams available three shifts per day.

SUMMARY

Geologic mapping methods and costs between the two other possible waste storage sites, URL, and the ES are not directly comparable because of:

(1) different geologic conditions i.e. lithology and fracturing

(2) different hydrologic conditions i.e. the ES located above the water table in the unsaturated zone

(3) different purpose, i.e. not a research facility

(4) Construction method, i.e. the ESF shaft will be lined as it is excavated

(5) Number of active headings, i.e. the ESF can have up to four active headings at one time requiring mapping

Restricting the contractor by permitting mapping during less than three shifts per day requires fewer geology staff and results in lower yearly geology personnel costs. Restricting the contractor by mapping less than three shifts also significantly reduces the time allowed for shaft and drift excavation because of standby time. This restriction can increase significantly the total construction time and cost, therefore more than offsetting three-shift-per-day mapping costs.

The above factors indicate that the cost of geologic mapping at the ESF must be evaluated in the context of information needs, construction method, impacts on the contractor, and resultant total project costs and schedule.

Enclosures

Copies to: Geologic Division, U.S. Geological Survey
Attn: MS-913 (Bob Raup and Ernie Glick, PO Box 25046, Denver Federal Center, Denver Colorado 80225

USGS RC/123242Z/I/Underground Geologic Mapping

U.S. DEPARTMENT OF ENERGY

OCRWM

Nevada Nuclear Waste Storage Investigations PROJECT

YUCCA MOUNTAIN

OGR

Exploratory Shaft Facility

Timing of Geologic Mapping During Shaft Excavation Cycle

Excavation cycle phase	*I Drill*	interim	*II Load*	interim	*III Shoot*	interim	*IV Muck*	interim	*V Support*	interim	*VI Utilities**	interim	*VII Lining**
Mapping Considerations (for key to letters see Figure 1b)	a,b,e, g,i	MAPPING POSSIBLE 1) contractor may need to find shot holes after mapping 2) shot holes may need cleaning after mapping	c,e,g,h	h	h	MAPPING POSSIBLE except for last round, since muck is still in place	b,h,i	MAPPING POSSIBLE	a,b,e,h	MAPPING POSSIBLE	MAPPING POSSIBLE c,d	PREFERRED MAPPING WINDOW	a,b,e,h
Contractor Preference (Ranking)		6				3		2		5	4	1	
USBR/USGS Preference (Ranking)		6				2		3		5	4	1	

* These operations occur about every 3rd round

Figure - 1a

U.S. DEPARTMENT OF ENERGY

OCRWM

OGR

Nevada Nuclear Waste Storage Investigations PROJECT

Nevada Nuclear Waste Storage Investigations Project

CONSIDERATIONS for MAPPING IMPACTS on CONSTRUCTION NNWSI, Exploratory Shaft Facility

a. Mapping always consists of washing and mapping

b. Must be able to move galloway (up and down) during mapping

c. Must have power for lighting

d. Must have water and air for washing

e. Must be able to see walls

f. Must be able to overlap photo with last mapped round

g. Limited exposure without support (no chain link until photographed)

h. General Safety

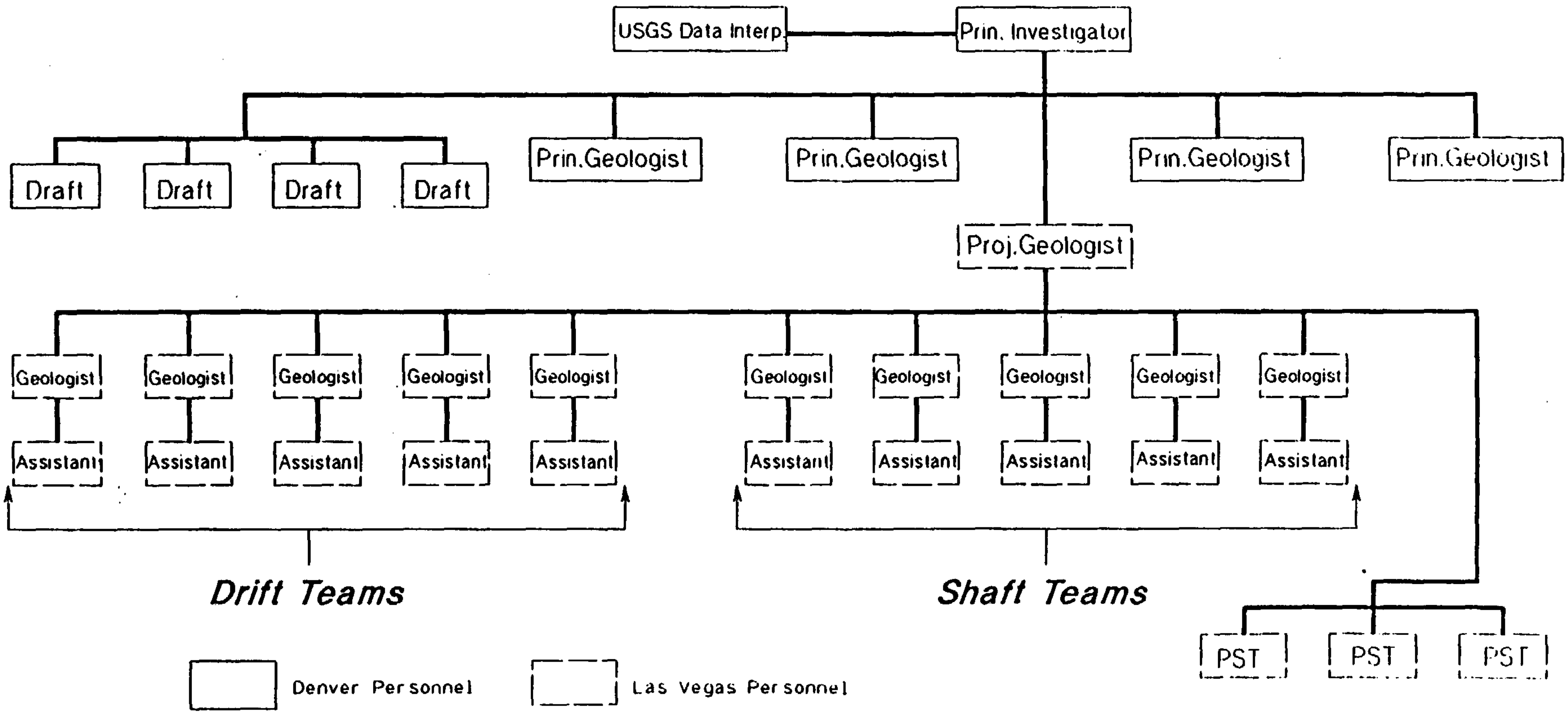
i. Bucket well will be covered during mapping

Figure - 1b

SHAFT AND DRIFT WALL MAPPING

ORGANIZATIONAL CHART

Conventional Mapping



Draft = Draftsperson

Prin. Investigator = Principal Investigator

USGS Data Interp. = USGS Data Interpretation

Proj. Geologist = Project Geologist

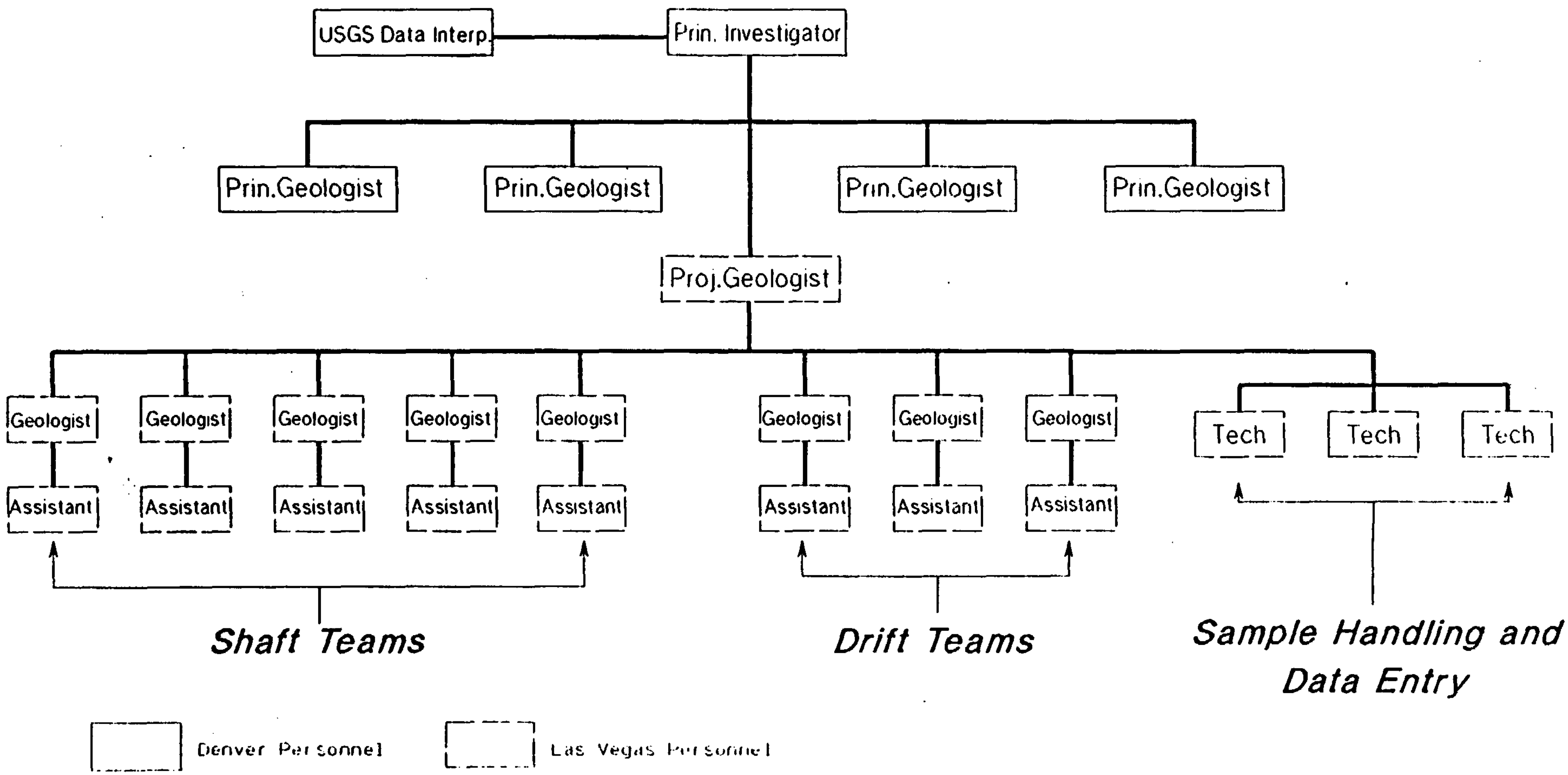
PST = Physical Science Technician

Figure 2

SHAFT AND DRIFT WALL MAPPING

ORGANIZATIONAL CHART
Photogrammetric Method

(Three Mapping Shifts per Day)



Tech = Physical Science Technician   Prin. Investigator = Principal Investigator   USGS Data Interp. = USGS Data Interpretation

Proj. Geologist = Project Geologist

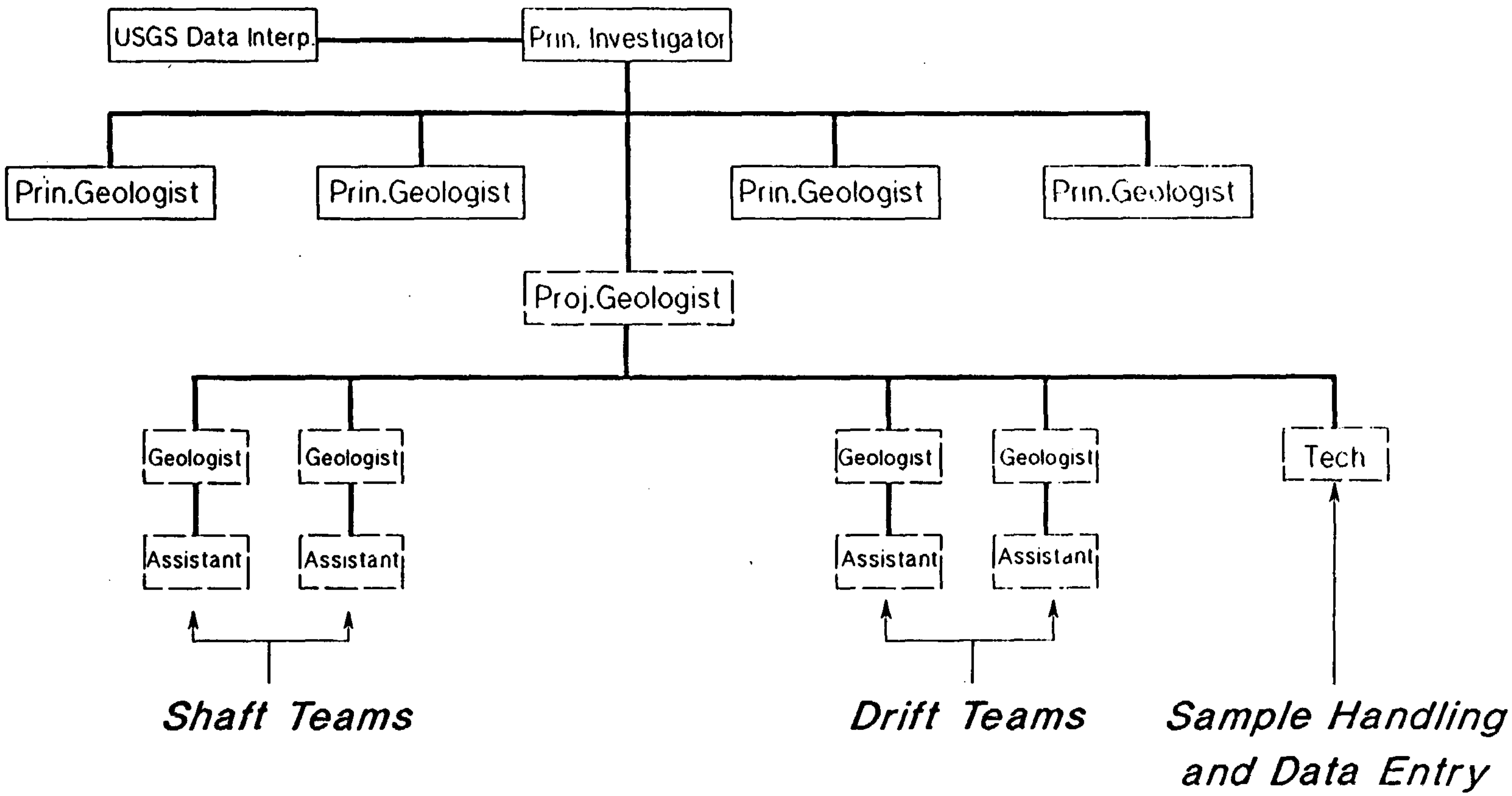
Figure 3

SHAFT AND DRIFT WALL MAPPING

ORGANIZATIONAL CHART

Photogrammetric Method

(One mapping shift per day)



Denver Personnel

Las Vegas Personnel

Tech = Physical Science Technician

Prin. Investigator = Principal Investigator

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Figure 4

SHAFT AND DRIFT WALL MAPPING
ORGANIZATIONAL CHART
Photogrammetric Method

(Two mapping shifts per day)

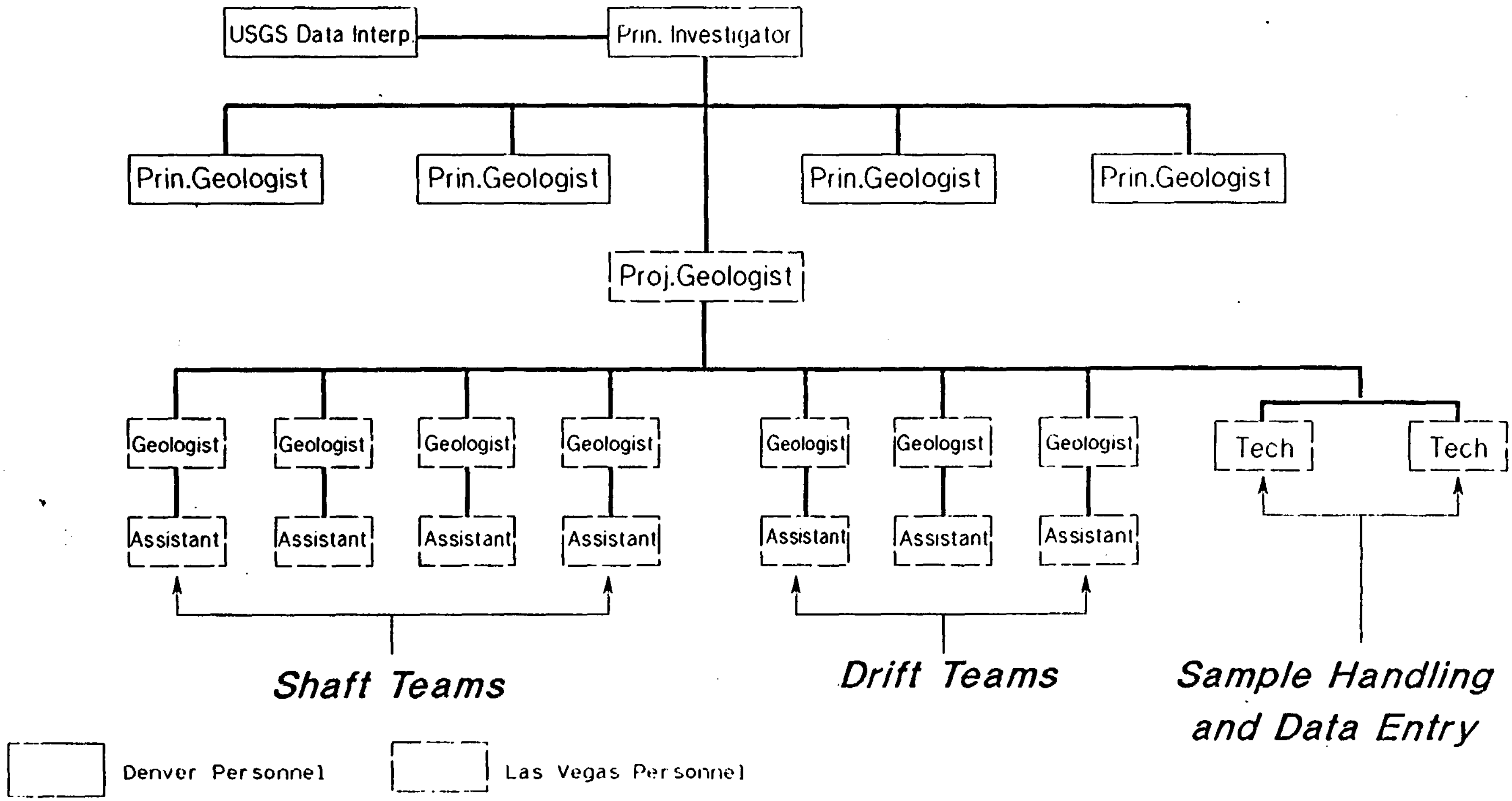

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Figure 5