see pocket 9 for enclosures

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JAN 16 1986

MEMORANDUM TO: Malcolm R. Knapp, Chief
WMGT

FROM: John Bradbury
Geochemistry Section, WMGT

Charlotte Abrams
Geology-Geophysics Section, WMGT

SUBJECT: TRIP REPORT: APPENDIX 7 VISIT TO NNWSI AND ATTENDANCE AT U.S. GEOLOGICAL SURVEY WATER RESOURCES DIVISION FIELD WORKSHOP, NEVADA AND CALIFORNIA, NOVEMBER 4-8, 1985.

On November 4-8, 1985, Yucca Mountain, G Tunnel and surrounding areas were visited and a USGS-WRD field workshop was attended. Purpose of the trip included examination of trenches and vein deposits, and familiarization with the site and areal geology. The purpose of the field workshop was to familiarize attendees with various types of spring deposits for comparison with possible analogs at Yucca Mountain (trenches 14 and 14a). All purposes were fulfilled. The source and age of this material is currently under investigation by the DOE and their contractors involved with NNWSI. The findings of the DOE study will have direct bearing on the suitability of the site for the burial of HLW. A listing of specific activities, discussions, and observations follows. Slides were taken where access and/or lighting permitted. A listing of slides for the field workshop and visit to the Yucca Mountain area is attached (attachment 1).

November 4, 1985

Field visit to east side and crest of Yucca Mountain by Charlotte Abrams (NRC-OR), Paul Prestholt (NRC-OR) and Lawrence McKague (LLNL).

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Activities

Examination of trenches 14 and 14a, and Tiva Canyon and Topopah Spring Members of the Paintbrush Tuff Formation, reconnaissance of proposed exploratory shaft area, and overview of Forty-mile Wash. See attachment 2, map of Yucca Mountain area.

Significant Observations and Discussion

The main purpose of the day's trip was to examine the geology in the area of the proposed HLW repository and to observe and examine trench 14 and trench 14a, specifically the carbonate and silica veins. Fault (Bow Ridge fault) zones and surrounding rock were observed in both trenches. Veins are best exposed in trench 14. Vein filling included carbonate and silica (opalescent). Silicified roots, like those commonly seen in both active and paleo- hydrothermal zones are included within the vein material. In addition, the veins in trench 14 are free of surface debris (sand, lithic fragments, mica fragments). The fault breccia zone in trench 14 contains rotated small blocks of the Tiva Canyon Member of the Paintbrush Tuff. Tuff in the trench contains pumice and lithic fragments.

On a traverse of Yucca Mountain samples of the Tiva Canyon tuff were examined. From Yucca Mountain the Solitario Canyon fault lineament and Forty-mile Wash, in addition to other distinct lineaments, were observed.

November 5, 1985

First day of USGS-WRD sponsored field workshop

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Activities

Visit to spring deposits at Nevares Mound in Death Valley, Ash Meadows and Amargosa Desert. Leader: Isaac Winograd (USGS-WRD). There were six stops on this day showing various types of deposits in Death Valley and the Amargosa Desert. Approximately 45 people were on this trip including John Bradbury (NRC), Charlotte Abrams (NRC), Paul Prestholt (NRC-OR), Lawrence McKague (LLNL), Charles Purcell (LLNL), representatives from the states of Nevada and New Mexico,and geoscientists from Los Alamos, DOE and the the USGS. Attachment 3 is an itinerary and maps for the field workshop. Attachment 4 is a collection of handouts given to attendees.

Significant Observations and Discussion

At the first stop along Furnace Creek calcite-filled veins, 1mm to 1m thick, branched upward and topped off in a paleo-tufa mound. The age of these deposits ranged from 1.5 to 2.5 my. These deposits occur 500m above the present day groundwater table.

The second stop was at Nevares Spring, where tufa is presently forming. The mound that has formed as a result of the precipitation of calcite from the groundwater is approximately 50 feet higher than the surrounding topography. Plant material acts as a nucleation surface for the deposition of calcite. The calcified layers of vegetation are overlain by younger and younger layers as the mound grows. The water temperature in this spring is 39°C and the flow rate is 400 gal/min.

The third stop (unscheduled) was to view from a distance a paleo-tufa deposit draped over lake sediments in Death Valley. The fourth stop, also unscheduled,

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looked at an ancient swamp (one possible interpretation) which was fed by springs for 200,000 years.

The fifth stop was at Crystal Pool in Ash Meadows. Although the water is saturated with respect to calcite, precipitation is not obvious. This may be due to the high flux (200 gal/min) and the well-drained nature of the pool. The temperature of this water is 32°C.

The sixth stop was Devil's Hole where the celebrated pupfish enjoys governmental protection. Work is still in progress at this site. The pool is one of the surface expressions of a large fault system in the carbonate sequence. Scuba divers have explored the channels and rooms in this system and found that it is at least 300 feet deep. They have discovered a partially filled room where shelves of calcite have formed on the walls of the chamber. The USGS suggested that by dating these deposits it is possible to determine the extent and rate of change of the groundwater table elevation over the past 320,000 years.

The temperatures of the water that precipitated the calcite in these deposits have been determined from stable isotope comparisons. From fluid inclusions extracted from the calcite, δD can be determined. Assuming the water from which the calcite precipitated is meteoric, $\delta^{18}O$ of the water can be calculated. Comparing the $\delta^{18}O$ of the water with that of the calcite and assuming equilibrium fractionation of the oxygen isotopes, the temperature of the calcite-water system can be determined. The deposits seen on the field trip have calculated temperatures of approximately 55°C. (From fluid inclusion homogenization studies, the deposits in the trenches at Yucca Mountain were precipitated at 65°C (personal comunication, November 5, 1985, Uel Clanton)).

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The method of estimating temperatures of formation may contain circular reasoning. By assuming the source waters were meteoric, the calculated temperatures necessarily are low. At Yucca Mountain where interaction between water and silicate host rocks could have occurred, the $\delta^{18}O$ of the water could be significantly greater than that of meteoric. In fact, if one assumes a geothermal water source, temperatures of greater than 100°C could be calculated. Thus, this method does not yield an unambiguous temperature.

The conclusions of the leaders of this trip were that the groundwater table has been generally dropping since the Pleistocene. Minor fluctuations (up and down) in water level have occurred throughout the recent past. With the uplift of the Sierra Nevadas, the climate has become more arid.

November 6, 1985

Activities

The second day of the field workshop was spent looking at spring deposits in the Glendale area, northeast of Las Vegas. Vein filling and spring minerals were compared with the deposits seen on the previous day. Leader: Gary Dixon (USGS-WRD). See map, attachment 3.

Significant Observations and Discussion

Dating the rocks was by the uranium trend method. The leaders at the workshop repeatedly indicated that for this method to work the system has to be closed. It was apparent that the criteria used to determine whether a system is closed is not straight forward. Sampling must be carefully done, noting textures, crystallinity, and chemistry.

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The field workshop was informative, but vein deposits viewed appeared unlike those at Yucca Mountain. Deposits viewed on the workshop trip were composed of calcite and lacked the silica found in veins in trenches 14 and 14a near Yucca Mountain.

November 7, 1985

Field Visit to NTS area.

Activities

Visited G Tunnel, Climax Stock, Boundary fault, and Carpetbag fault. View and discussion of various aspects of the general geology of the area. Personnel involved in visit: Charlotte Abrams (NRC), Paul Prestholt (NRC-OR), Lawrence McKague (LLNL), and Charles Purcell (LLNL). See map, attachment 5.

Significant Observations and Discussion

Lawrence McKague (LLNL) guided the group across the test site area and gave an excellent explanation of the local geology. The Climax Granodiorite is a pyrite-bearing biotite-microcline-quartz-plagioclase rock with coarse microcline (up to 1½" long). The Boundary fault occurs on the east side of the Climax stock. There the Climax Granodiorite is brecciated and the breccia is cut by siliceous veins. The Carpetbag fault (30-90 thousand yrs. old) experienced displacement after a recent nuclear test. The fault scarp produced by the recent movement is uneroded. Trenches have been cut across the fault exposing some localized veins. These veins probably represent pedogenic

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deposits as the veins contain debris (quartz grains and mica) possibly from the overlying soil.

November 8, 1985

Visit to OR's office. In attendance: Paul Prestholt (NRC-OR) and Charlotte Abrams (NRC).

Activities

Discussion of workshop and familiarization with affiliation of attendees. Discussion of site and look at pertinent references.

RECOMMENDATIONS: Comparison of veins in trench 14 with veins exposed in trench cutting the Carpetbag fault. Veins exposed in trenches cutting the Carpetbag fault appear to be pedogenic. As one of the interpretations made for the veins at trench 14 is a pedogenic interpretation, comparison of the two areas might be beneficial.

Charlotte Abrams
Geology-Geophysics Section, WMGT

John W. Bradbury
Geochemistry Section, WMGT

Enclosure:
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See memo to Knapp fm Bradbury 1/16/86
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ATTACHMENT 1

The following is a listing of slides taken on the U.S. Geological Survey Water Resources Division field workshop, November 5-6, 1985. Slides are on file in Charlotte Abrams' office.

1. Calcite veins in Funeral Formation
   Stop 1, Day 1

2. View into Death Valley

3. Nevares Spring Mound Death Valley - view to west
   Stop 2, Day 1

4. Nevares Spring Mound, Death Valley - view to east
   Stop 2, Day 1

5. Crystal Spring in Ash Meadows
   Stop 5, Day 1

6. Crystal Spring
   Stop 6, Day 1

7. Devil's Hole
   Stop 6, Day 1

8. Calcite deposit, Devil's Hole area
   Stop 6, Day 1

9. Spring mound near Glendale
   Stop 1, Day 2

10. View of other Spring mounds along fault trace
    Stop 1, Day 2

11. Calcite veins, spring mounds
    Stop 1, Day 2

12. Tufa mound top of spring mound
    Stop 1, Day 2

13. Bryon Canyon fault termination at Hogan Badlands
    Stop 5, Day 2

14. Hogan Badlands - Canyon
    Stop 5, Day 2

15. Hogan Badlands - Canyon - tilted beds - Power plant in background
    Stop 5, Day 2

16. Fieldtrip participants with scattered calcite deposits, Wildcat Wash
    Stop 7, Day 2

17. Vein deposits - Wildcat Wash
    Stop 7, Day 2

The following is a listing of slides taken in the Yucca Mountain area, November 4, 7, and 8, 1985. Slides are on file in Charlotte Abrams' office.

1. Fault zone, trench 14
2. Vein deposits, trench 14
3. Vein deposits, trench 14
4. Vein deposits, trench 14
5. Vein deposits, trench 14
6. View down trench 14
7. Fault zone and adjacent veins, trench 14
8. Trench 14, veined breccia zone
9. Close-up of veins, trench 14
10. Top of trench 14a and view from top
11. Tiva Canyon Member, welded tuff as seen in trench 14
12. Veins, trench 14
13. Tiva Canyon Member, tuff with pumice and lithic fragments, trench 14
14. View of Solitario Canyon fault lineament from Yucca Mountain
15. Crater flats with cones. View looking west from Yucca Mountain
16. Busted Butte
17. View of Calico Hills
18. Forty-mile Wash, looking north-northeast from Yucca Mountain
19. Forty-mile Wash, looking south from Yucca Mountain
20. Exposure of tuff with rubble zone in G tunnel
21. G tunnel heat test
22. Container, G tunnel

Attachment 2

Map, Day 1, November 4, 1985

FIELD WORKSHOP
Carbonate/Silicate Deposits
Southern Nevada
5th/6th November 1985

General Information

Dates: Tuesday and Wednesday 5th and 6th November 1985

Starting Point: Parking lot - Somerset House Motel
294 Convention Center Dr.
Las Vegas, NV
Phone 735-4411

Time: 0730 both days

Contact: Joe Downey
USGS - WRD MS 416
Denver Federal Center
Denver, CO 80225
Phone FTS 776-5195, 776-5044

5th November: Visit Spring deposits in Death Valley, Ash Meadows and the Amargosa Desert - trip leader: Ike Winograd. USGS see map 1. Because of the lack of facilities in this area, box lunches will be available.

6th November: Visit Spring deposits near Glendale, Nevada northeast of Las Vegas. Trip leader: Gary Dixon USGS. See map 2. Lunch facilities should be available in this area.

Misc.: The purpose of this workshop is to familiarize everyone with the many forms of calcite/silicate deposits found in Southern Nevada in order to have a common frame of reference in future discussions of the geology of Yucca Mountain.

Transportation: Car or van - some short walks will be necessary - may use your own vehicle if desired.

Death Valley, Ash Meadows and Amargosa Desert Area
5 November 1985

Map 1

Stop 1. Nevares Spring mound. A broad range of modern to Pleistocene tufa morphologies on display. Time on outcrop - 1/2 to 3/4 hour.

Stop 2. View from road of spectacular calcite vein swarm and related tufas of early Pleistocene age. 10 minute talk by Ike.

Stop 3. Spring and adjacent tufa mound. A view of one of Ash Meadow's major springs and only tufa mound.

Stop 4. Devils Hole and vicinity. Veins tufas, ojos, authigenic clays and chalks, all on display within a radius of 1/2 mile. Words by Winograd and Riggs.

Stop 5, 6,... Various calcite deposits in the Ash Meadows area; time permitting.

Late Cenozoic spring-carbonate deposits
of the White river aquifer system,
Arrow Canyon Range, Nevada

Field trip itinerary for November 6, 1985
Las Vegas to Glendale and Coyote Spring Valley and return.

0745 Assemble at Somerset House Motel parking lot. 294 Convention Center Dr. Las Vegas

0800 Travel NE on I-15

0845 Exit at Ute interchange
Travel 5 miles NW on Ute road

0900 STOP 1 Spring Mound, 3 m thick, Pleistocene, unconformably overlies calcareous lake beds of Muddy Creek Formation. Surroundings high pediment with thick caliche top is cut by many small fractures and faults. One of these faults displaces the caliche and underlying lake beds about 1 m and at an earlier time was the conduit for the spring mound.

1000 Return to Ute road
Travel NW 1.2 miles to abandoned quarry road
Travel S on quarry road to wash, walk across wash and up to south bank to 2 small hills

1030 STOP 2 Two spring mounds cut by Pleistocene fault which was conduit for the spring mounds.

1130 Return to vans
Return SE on Ute road to Powerline road
Travel 4.5 miles NE on Powerline road to fault scarp

1200 STOP 3 Bryon fault scarp, late Pleistocene, 3.5 m displacement of thick caliche soil on high pediment.

1215 Continue about 0.5 mile E to overlook point.

1230 ?Lunch stop? (bag lunch or lunch later at Glendale?)
STOP 4 Overview of Hogan badlands eroded in Muddy Creek Formation below high pediment. See faults displacing and tilting Muddy Creek lake beds. White calcareous lake beds down dropped tens of meters against red clay and silt lake beds. White beds can be traced 0.5 miles to N to spring source of carbonate beds in Muddy Creek Formation (12?-6? Ma) at Hogan Spring.

1330 Return to Powerline road and follow NE to Nevada Power Plant and Moapa and State Highway 168.

1400 State Highway 168
Travel NW 7 miles to Muddy River Springs

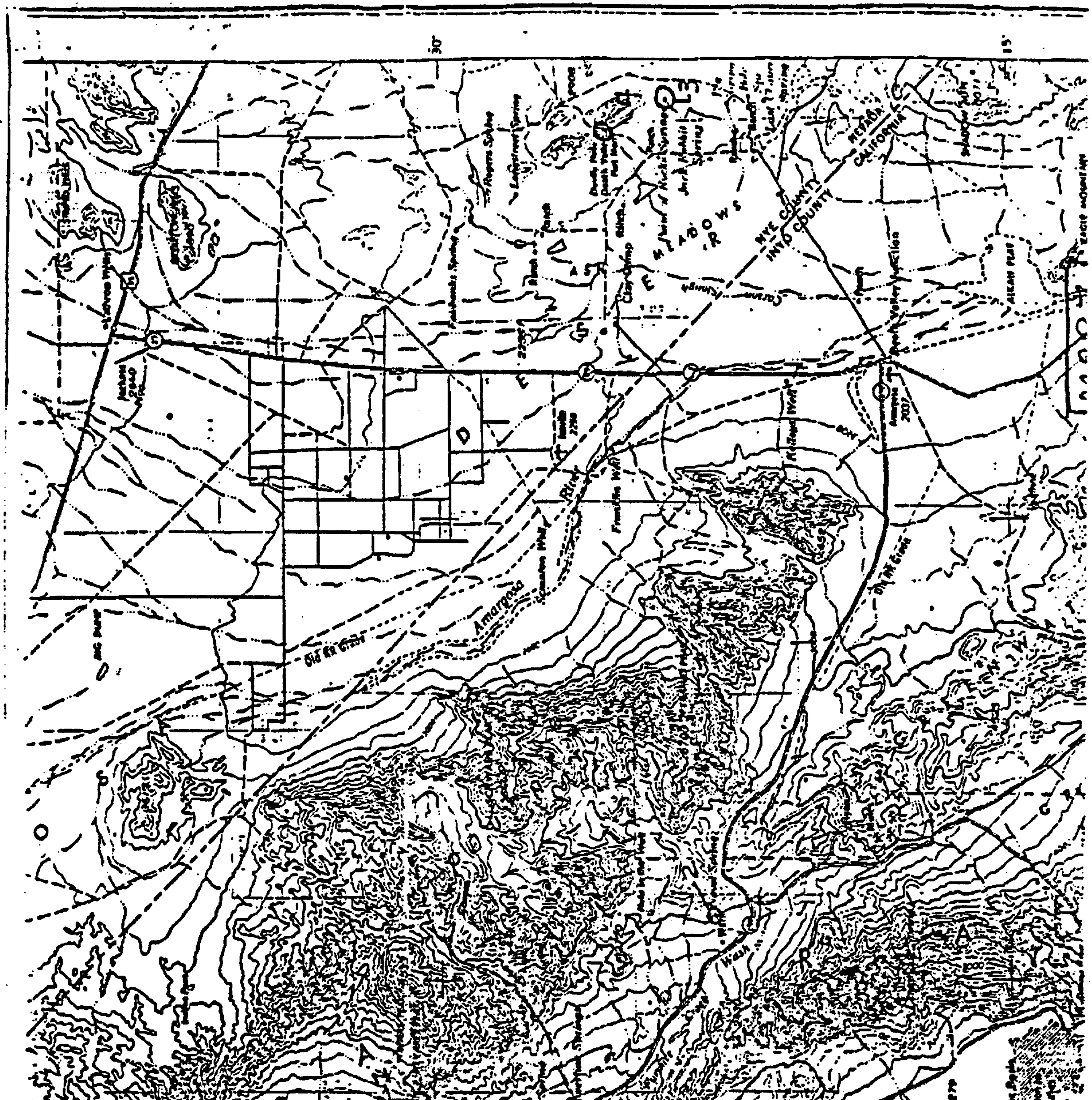
1415 STOP 5 Muddy River Springs overview; 38,000 acre-feet of water from the White River aquifer discharges from these springs.

1430 Travel NW 8 miles on Highway 168
Junction with abandoned US-93
Travel N about 1 mile up Wildcat Wash

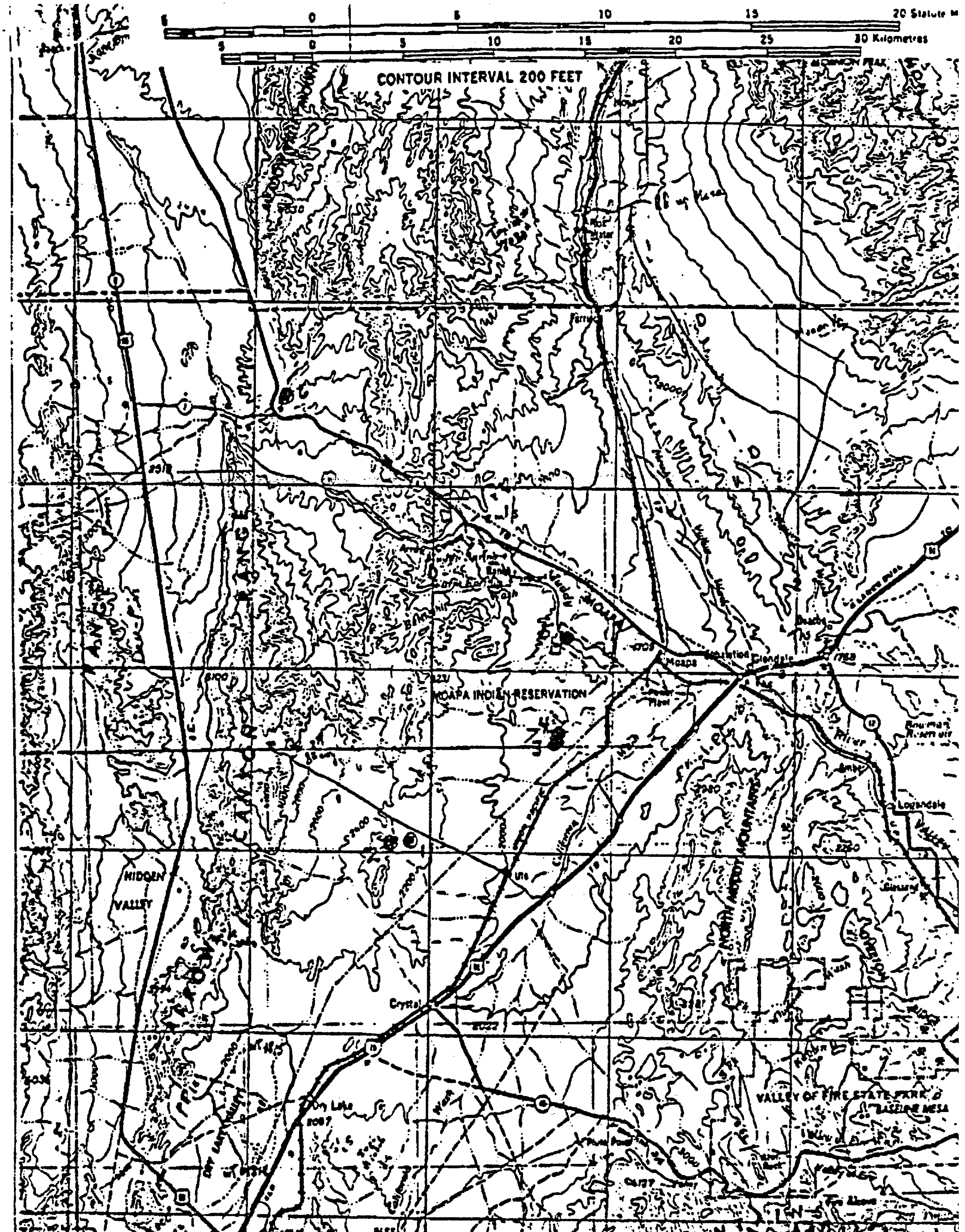
1500 STOP 6 Wildcat Wash; north-trending, fault controlled, plumbing system for spring-carbonate deposits of late Miocene to late Pleistocene age. Thick tabular beds of spring carbonate in Muddy Creek lake beds pinchout 0.5 miles to east and 1.5 miles to south. Laminated spring carbonate in abundant veins and pipes fill obilque fractures in carbonate-cemented conglomerate of a deltaic facies of the Muddy Creek Formation as well as fill fractures in the Ordovician Pogonip limestone.

1630 Return to Highway 168, travel W into Coyote Spring Valley
Return to Las Vegas via US-93 and I-15

1730 Las Vegas.



30'
15'
NEVADA
CALIFORNIA
NYE COUNTY
INYO COUNTY
MEADOWS
Amargosa



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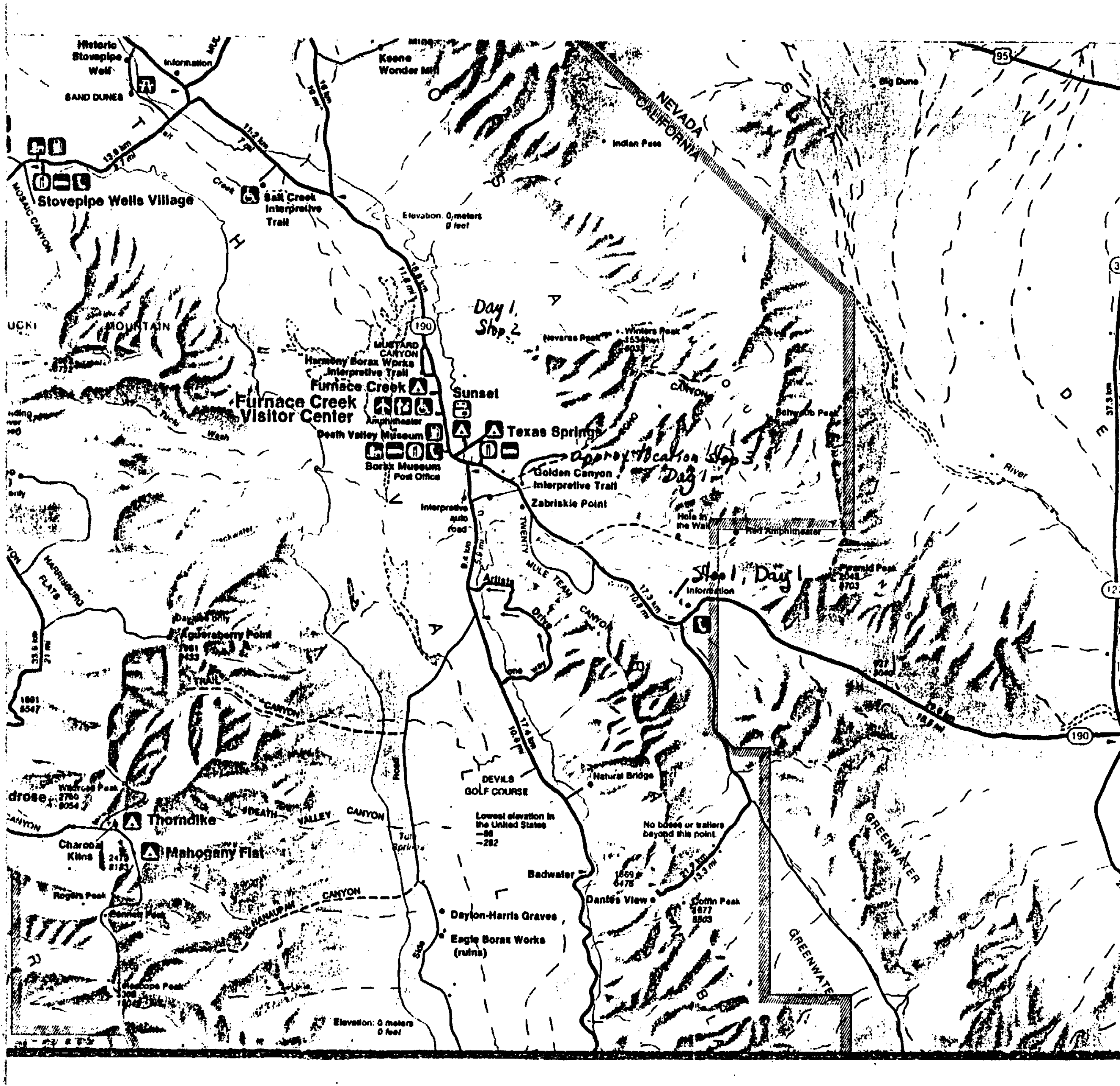
30 Kilometres
CONTOUR INTERVAL 200 FEET
MOAPA INDIAN RESERVATION
Moapa
Glendale
Logandale
HIDDEN
VALLEY
Crystal
NORTH MUDDY MOUNTAINS
VALLEY OF FIRE STATE PARK
BASELINE MESA



Historic Stovepipe Well
Information
SAND DUNES
Keene Wonder Mill
NEVADA
CALIFORNIA
Big Dune
Indian Pass
95
Stovepipe Wells Village
MOSAIC CANYON
Salt Creek Interpretive Trail
Elevation 0 meters 0 feet
Day 1, Stop 2
190
MUSTARD CANYON
Harmony Borax Works Interpretive Trail
Nevares Peak
Winters Peak
Furnace Creek
Sunset
Furnace Creek Visitor Center
Amphitheater
Texas Springs
Death Valley Museum
Borax Museum
Post Office
Golden Canyon Interpretive Trail
Approx location Stop 3, Day 1
Zabriskie Point
Interpretive auto road
Hole in the Wall
Red Amphitheater
Pyramid Peak
Stop 1, Day 1
Information
TWENTY MULE TEAM CANYON
Artists Drive
one way
HARRISBURG FLATS
Daylight only
Aguereberry Point
TRAIL CANYON
Wildrose Peak
Thorndike
DEATH VALLEY CANYON
Charcoal Kilns
Mahogany Flat
Rogers Peak
Bennett Peak
HANAUPAH CANYON
Telescope Peak
DEVILS GOLF COURSE
Natural Bridge
Lowest elevation in the United States
No buses or trailers beyond this point.
Badwater
Dantes View
Coffin Peak
Dayton-Harris Graves
Eagle Borax Works (ruins)
GREENWATER
River
Elevation: 0 meters 0 feet

ATTACHMENT 4
field trip hand-outs