GEOLOGICAL AND GEOPHYSICAL METHODS USED IN THE HAZARDOUS WASTE INDUSTRY

Environmental Update/ Henry Wise

The sources of contamination are many and varied but problems inevitably arise when the environment is inadequately protected. Before corrective action can be taken, the source and size of the problem must be determined. Geological, hydrological and chemical studies are needed to create a reasonable model of the hydrologic system involved in the movement of pollutants. Information must be gathered to determine what type of contaminant is involved, how it got there, and whether or not the source of contamination is a continuing problem.

A literature and data search often provides key information on the geology of the area, the physical and chemical make up of the soil, wells drilled in the area, and ground water chemistry. Poorly cemented wells and open holes screened across multiple aquifers often provide open pathways for contaminants. Faults and channeling, so important to the migration of fluids, must be well documented. Remediation efforts can proceed if information on permeability, porosity, hydraulic conductivity, transmissivity, and storativity is available. Otherwise, a sampling and testing program is necessary to determine these factors.

Once the nature of the problem is known, the size of the area is determined. Geophysics is often used as a preliminary tool in delineating the area of contamination. This includes magnetic surveys, terrain conductivity surveys, electrical resistivity surveys, subsurface radar, seismic refraction, temperature surveys, and the cone penetrometer.

Magnetic surveys are used to locate buried ferromagnetic materials such as steel drums. Terrain conductivity surveys which utilize inductive electromagnetic techniques, detect buried non-ferromagnetic conductors but cannot differentiate them from ferromagnetic conductors. Conductivity surveys are useful in delineating the boundaries of polluted areas because they are sensitive to the type of soil, subsurface porosity, hydraulic permeability, moisture content, depth to and type of bedrock, and the concentration of dissolved electrolytes. A very inexpensive detection method related to electrical conductivity is the use of metal detectors. Their use is limited to the detection of near surface metallic objects buried within five feet of the surface.

Electrical resisitivity surveys measure the relative difficulty for an electric current to pass through the earth. Since most soil constituents are good insulators, electrical resistivity actually measures soil moisture and the ionic concentration of the water. This techniuqe is most useful in determining the lateral extent of contaminant migration. One drawback to resistivity surveys is that they are time consuming. Electrodes must be driven into the ground and accurately arranged. This can be difficult where concrete or frozen ground is involved. Electrical resistivity works best where high resistivity contrast exists. However, if the depth to the water table is too great, the thickness of unsaturated sediments can mask any contrast between contaminated and natural groundwater.

Ground penetrating radar employs an advanced impulse radar system to send a few pulses of electromagnetic radiation (100 MHz - 900 MHz) into the ground from a highly damped antenna. Reflections occur when objects of different dielectric constant are encountered. The round trip travel time indicates the depth to the buried object. Ground penetrating radar not only locates buried objects such as drums but also provides qualitative information on drum density. It can also detect interfaces between disturbed and undistrubed soil (such as trench bottoms), and measures plumes of high chemical concentration. Ground penetrating radar is a relatively simple device to use but requires access for a vehicle.

Seismic refraction techniques are used to determine the thickness and depth of geologic layers or velocity of seismic waves within the layers. Refraction methods are often used to map depths to bedrock, clay layers, and the water table. The seismic method is capable of locating and defining burial pits and trenches. The problem with seismic surveys is that they are labor intensive and costly due to specialized equipment.

Temperature surveys have been used to determine the boundaries of landfills. The composting action of bacteria releases heat. This temperature differential can be several degrees celsius. Heat moves through the soil by conduction rather than via the movement of leachate. Occasionally, the movement of leachate can be detected via temperature surveys, but only if it is moving quickly, such as through the permeable gravels of drain tiles and utility lines.

A cone penetromenter survey involves pushing a cone shaped instrument into the soil and measuring its resistance to penetration. These measurements are compared to existing charts in order to determine the type of sediment penetrated. Some of the disadvantages of the cone penetrometer is that specialized equipment is used and easy vehicle access to the sampling locality is also required.

Sample collection is conducted to insure that the geophysical techniques mentioned above provide a true representation of the subsurface stratigraphy. Samples are typically sediment cores and ground water samples. Core samples are collected from the shallow subsurface using a drilling rig. These cores provide a continuous record of the stratigraphy, with samples taken at designated intervals for

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chemical and physical testing. Chemical testing will determine the type and relative concentration of contaminant in the sediment. Physical testing will determine the sediment's bulk density, horizontal and vertical permeabilities, and porosity. This information is important in order to accurately model the contaminant plume and its movement.

In some cases once a core hole is drilled, it may be electrically logged before being completed as a monitoring well. After well installation, a water sampling program is undertaken to identify the type and degree of water contamination. It is important to drill core holes well beyond the contaminant plume in order to determine its size and shape. The baseline chemistry of the uncontaminated ground water can be determined by wells outside the plume. These wells can also be used to monitor the migration of the contaminant plume. The wells provide data on water levels which can be used to determine the general flow direction of the water within the monitored aquifer. Constant rate pumping tests and step drawdown tests are usually used to determine the transmissivity, storativity, and hydraulic conductivity of the aquifer.

Tracer dyes are sometimes used to determine aquifer flow rates and direction. Specific dyes are usually placed into the well bore and allowed to migrate within the monitored aquifer. The periodic sampling of nearby monitor wells will determine how quickly the dye moves across the distance, thereby yielding the average velocity and direction of movement.

Once all of the available data is collected and compiled, models can be constructred to best visualize the extent of the problem. These models can then be used to determine what method can be used to remediate the problem.

Mr. Wise is a consulting geologist involved in Environmental affairs. His previous experience has been in uranium exploitation and exploration.

Environmental Committee
Arlin Howles, Chairman

H.G.S. Golf Tournament

The annual HGS Golf Tournament will be held on Monday, March 16, 1987 Kingwood Country Club with its three 18 hole courses will again be the site of our tournament.

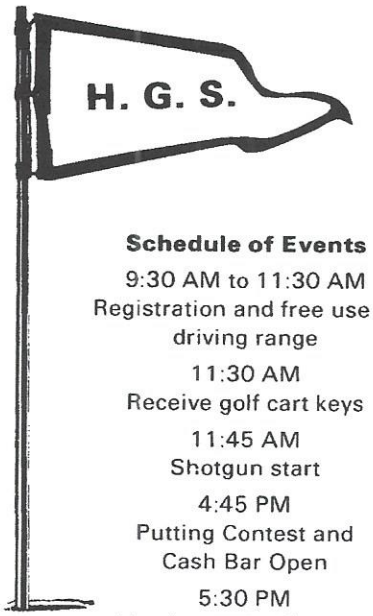
The tournament will be a four-man team, best ball tournament with both individual and team prizes. A shot-gun start at 11:45 AM using all three courses will be followed by a putting contes and an informal Hamburger Buffet with presentation of awards. A player may select his/her own foursome or be placed in a foursome by the tournament committee. The field will be split into three flights according to handicap and each flight will play on one of the three courses. After field is full and flights assigned, any substitute must have a higher handicap than the lowest handicap in the assigned flight. **NOTE:** due to the limited number of available golf carts, entries will be limited to the first ninety-six (96) four-man teams entered (384 total golfers).

Entry fee will be $45.00 for HGS members and $60.00 for non-members. The deadline for entries will be March 10, 1987. The entry fee will pay for green fees, golf carts, driving range use with practice balls, and the awards dinner. So get your group together, come out and enjoy the competition, food, and the fun.

To enter, fill out the following entry blank and mail with your entry fee (payable to **HGS Entertainment Fund**) to:

Neil Sivers
Sivers Seismic Services, Inc.
P.O. Box 460348
Houston, Texas 77056-8348
Phone: 965-9650

All entries received will be acknowledged by return phone call.



Schedule of Events

9:30 AM to 11:30 AM
Registration and free use of driving range

11:30 AM
Receive golf cart keys

11:45 AM
Shotgun start

4:45 PM
Putting Contest and Cash Bar Open

5:30 PM
Hamburger Buffet with Award Presentation

Name _____ Amount Enclosed _____

Company _____ Phone _____

Foursome Members (Please Print)	HGS member	Non member	Company	Handicap or Average Score
1. _____				
2. _____				
3. _____				
4. _____				

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BULLETIN

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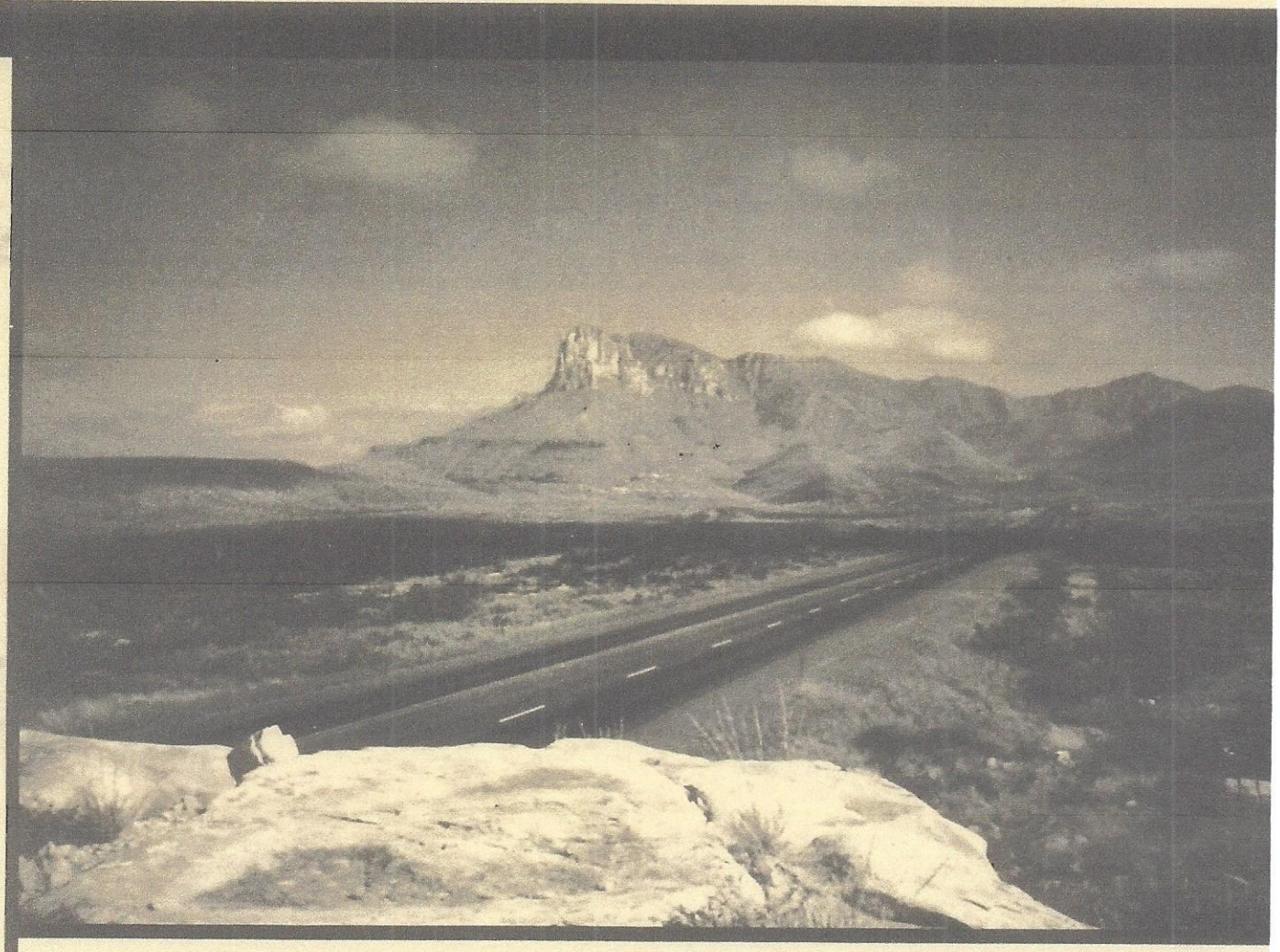

HGS FEBRUARY CALENDAR

FEBRUARY 10, 1987 (HGS-HAPL Dinner Meeting)
"Geographic Changes of the Earth as Viewed from Space"
John M. Lounge, NASA Astronaut, Houston
Social Period - 6:00 PM, Dinner and Meeting - 7:00 PM
Westin Galleria Hotel, 5060 Alabama
Reservations by prepayment only. Must be received no later than **Friday, February 6.** No refunds after February 6.

FEBRUARY 18, 1987 (Dinner Meeting)
"Evolution of the South-Eastern Corner of the Caribbean During the Last 25 Million Years"
Kevin Burke, University of Houston, Houston
HGS INTERNATIONAL EXPLORATIONISTS
Social period - 5:30 PM, Dinner and Meeting - 6:30 PM
Westin Galleria, 5060 Alabama
Tickets must be purchased by **Monday, February 8.**

FEBRUARY 25, 1987 (Luncheon Meeting)
"Why The Gulf of Mexico"
Paul S. Horvath, Century Offshore Management, New Orleans
Social period - 11:30 AM, Luncheon and Meeting - 12:00 Noon
Doubletree (Meridien) Hotel, 400 Dallas
Reservations made by name only, telephone **771-8315.** Must be made or cancelled by **noon, Friday, February 20.**

FEBRUARY 17-19, 1987
HGS School - "Introduction to Practical Hydrology"
Jungman Branch Library, 5830 Westheimer

FEBRUARY 21, 1987
Barbeque and Western Dance, Regal Ranch, Stafford

FEBRUARY 21, 1987
HGS Tennis Tournament,
Quail Valley Country Club Tennis Center