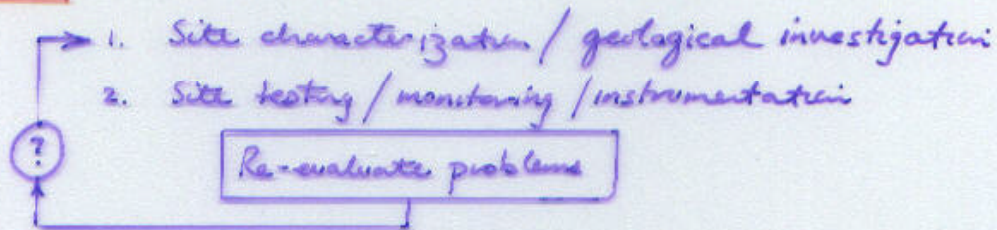


GROUNDWATER RESOURCE EVALUATION / CHARACTERIZATION

Require knowledge of geology and hydrogeology:

1. Evaluate quantities available for use: Domestic/Industrial
2. Establish baseline characteristics (pre-mining).
3. Estimate potential for problems -
 - large inflows
 - water pressures & instability

Two phases



Site characterization

1. Existing materials search.
2. Additional site data acquisition.

INVESTIGATION PROCEDURE

Desk Study

- o Previous reports - adjacent and current properties
 - confidentiality
 - public record reports (DER/EPA/Regulation)
 - geological guides/maps. (USGS/PA Geol. S.)
- o Aerial photographs -
 - geology / surficial geology
 - seep locations/wetlands

- Stereo photos - 3-D and geology
- Orthophotos (mosaics) & contouring
 - Low angle light/obliques
 - invisible wavelength (infra red).

Field Mapping

- o Verify results from air mapping
- o Sampling for analysis and material characterization
 - confirm/determine materials

INVESTIGATION PROCEDURES (continued).

Methods of detailed investigation

- o Indirect (non-intrusive/non-destructive)
- o Direct (intrusive ...).

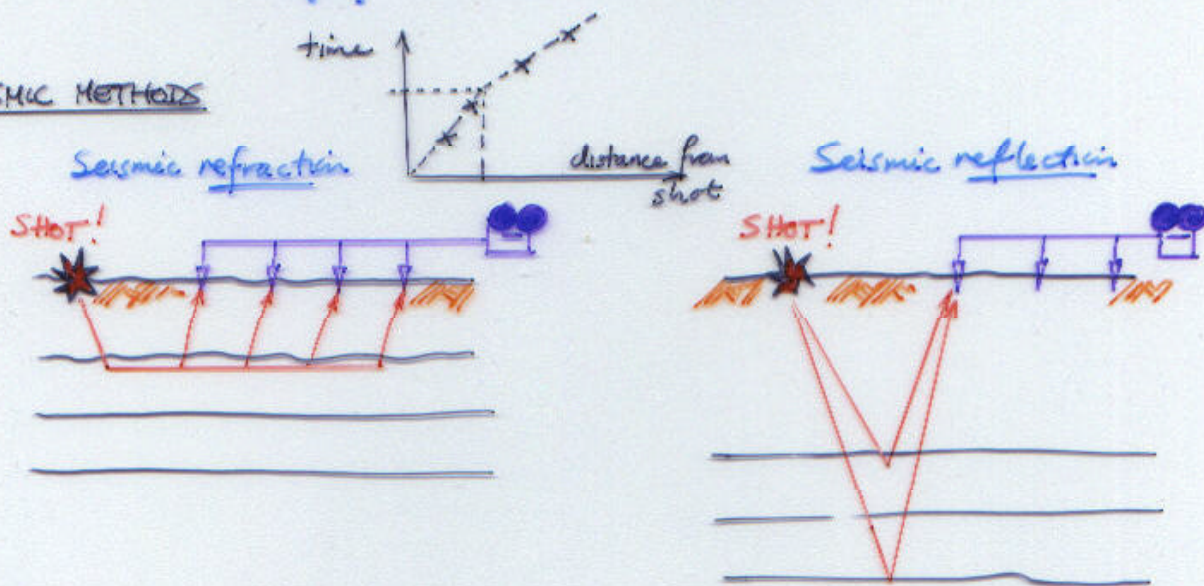
Require to determine 'geology' or 'hydrogeology'.

INDIRECT

Geophysical methods to 'see' inside porous media.

Detect geological boundaries but also define changing saturation boundaries.

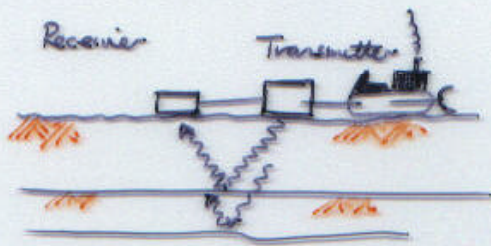
SEISMIC METHODS



1. Problems in defining layers/strata in complex geology
2. Recognizes 'seismic' differences in materials and not necessarily 'hydrologic' differences
3. Influenced by water levels (influences seismic vel.)
4. Correlation with boreholes.

INVESTIGATION PROCEDURES (Continued)

GPR (Ground Penetrating Radar)



- E-M radiation @ 10-100 MHz
- Controlled by dielectric constant
- Measure arrival times/transmission strength

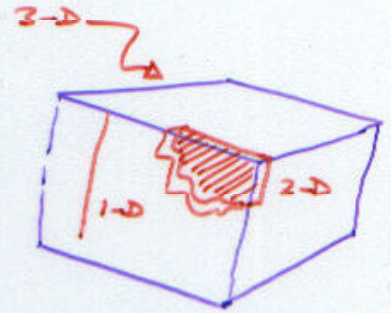
Picks-up interfaces of dielectric constants.
Very sensitive to saturation and saturant

Plume evolution studies using geophysical methods.

INVESTIGATION PROCEDURES (continued).

DIRECT METHODS

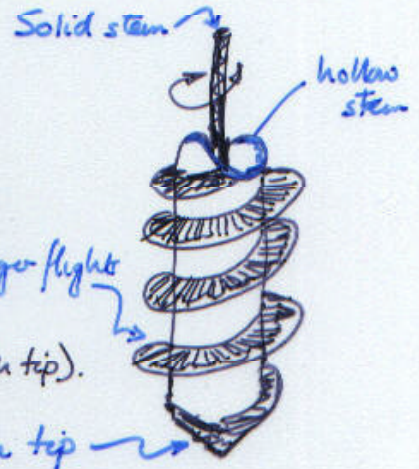
- 1-D Drilling and adits
- 2-D Trenching with backhoe
- 3-D Geophysical



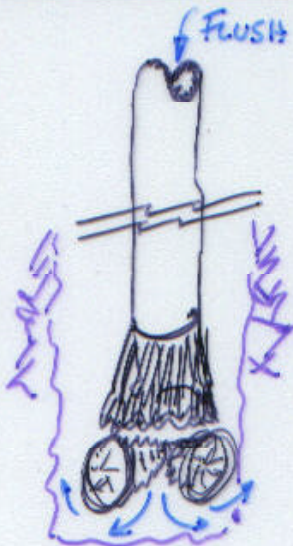
Drilling Methods

Auger boring

- Soils and v. soft rock only
- No casing needed
- Fast
- Undisturbed sampling (through tip).



Air or Water Flush Boring

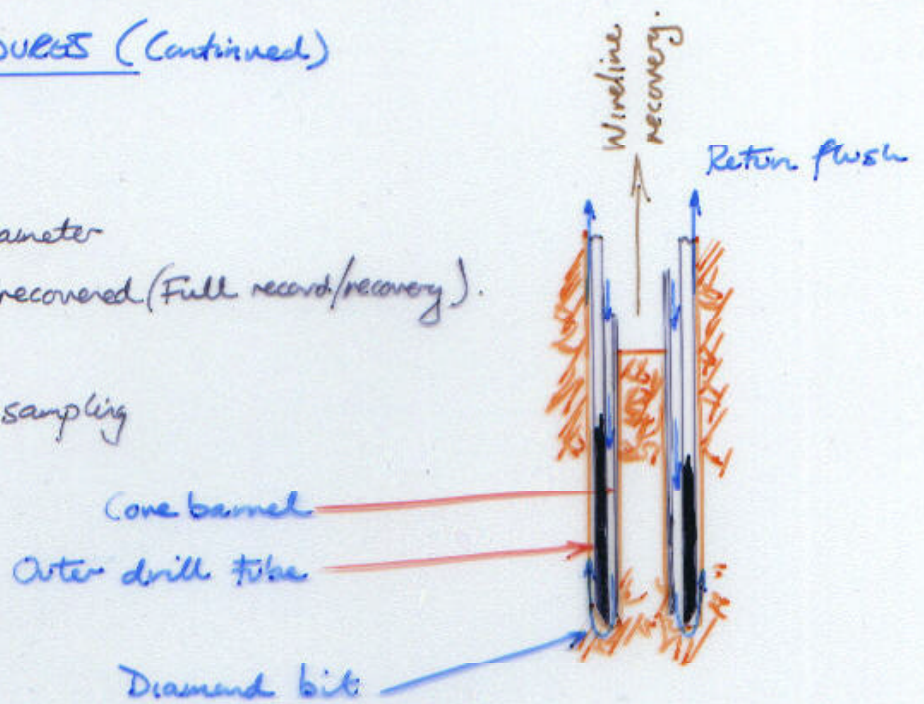


- Tricone bit
- Air/water flush - fluid losses → formation
- Casing or mud supported hole
- Soil and rock boring
- Soil testing and sampling - retract line
- No sample recovered.

INVESTIGATION PROCEDURES (Continued)

Diamond Drilling

- Small diameter
- Samples recovered (Full record/recovery).
- Slow
- Wireline sampling



RESULTING HOLES USED TO MAX EXTENT - INSTRUMENTATION

\$10/ft. diamond drill (1993).