Nuclear Geophysics

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(1)

Advantages	Disadvantages
(a) Air-borne Nuclear Data:	
• The airborne Gamma ray spectrometer benefits for environmental assessment of nuclear radiation in areas exposed to radioactive material	• Initial costs of aircraft is high
• Air-borne foot printing provides rapid, well defined spatial images of natural and man-made contamination	• In some cases due to external factors like wind, weather, terrain, the spatial resolution is limited
• Air-borne acquisition of data ~~gura~~ guarantee good spatial resolution in short time span	• Only gamma measurements can be recorded
• Efficient and large coverage per time unit	
• Integral view of area with resolution of measurements related to the altitude and speed of aircraft	
(b) Helicopter	
• High spatial resolution	• Large size, hence not easily maneuvered and accessible in tricky areas.
• Covers large area in less time	• Highly dependent on weather conditions
• Changeable sensors	• Expensive

① ⓒ Drone

Advantages	Disadvantages
• Can access, tricky areas and easily controlled	• control cover area as efficiently as helicopters
• Fairly cheaper than other airborne alternatives	• very easily damaged by rough weather conditions

Justification

Use of ground based Em and aero-magnetic surveys along with gamma ray spectrometric studies for uranium deposits since uranium mineralization does not ~~eff~~ differ in resistivity from ~~not~~ environment and the spatial extent of an ore body is often small hence the direct detection of uranium by measuring resistivity, conductivity is difficult. It is possible to utilize Em method to detect subsurface geological targets often associated with uranium mineralization. Recent paleo channel exploration has seen wide use of this process More detailed we can be seen through availability of GPS it has tremendously improved the spatial accuracy of air-borne surveys. At the same time those in exploration begin to design surveys so they could resolve subtle magnetic field variations.

(2) Shales ordinarily have sufficient permeability and porosity to allow signifant fluid to a wellbore, Therefore most shales are not commericial sources of natural, gas.

We know shale is a natural gas predominantly methane found in shale rock, and The natural gas from shale is referred to as unconventional which refer to the type of rock it is found in

Advantages of unconventional hydrocarbon over conventional hydrocarbon are :-

- Unlike conventional sources refining is not very important.
- It maybe difficult to extract but natural gas is much more abundant on earth conventional resources are depleting and very small by volume
- Natural gas is much more abundant, reliable and clean burning from unconventional sources
- Developement of unconventional resources has significant economic potential as the largest portion of oil and gas is estimated to exist in unconventional deposite.

Work flow

Integrates formation evaluation in lateral — Shale Characterization

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Increase ROP — Target ~~Dttat~~ Dilineation

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Geosteer, identify faults & fractures — Geosteering faults, fractures

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Drilling Efficiency

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Provide specific perforation recommendation — Stress and Mineralogy

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Completion effectiveness

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Calibrate data — Production evaluation (Production logs)

3a) The process of accumulation counts by using nuclear methods is subject to random statistical fluctuations. The most commonly accepted measurement error is standard deviation since its follows poisson distribution. Standard deviation of recorded count is square root of the number of counts

$N_A = 1000, \quad N_B = 2000.$

S.D of $A_0 = \sqrt{N_A} = \sqrt{1000} = 31.62$

S.D of $B = \sqrt{N_B} = \sqrt{2000} = 44.72.$

$r = N_A / N_B$

Poisson Distribution $= P(N) = \dfrac{e^{-\lambda} \lambda^N}{N!}$

$S.D = \sqrt{\dfrac{N_A}{N_B}} = \sqrt{\dfrac{1000}{2000}} = \dfrac{1}{\sqrt{2}}$

3b) $A = A_0 e^{-\lambda_x T_a}$

T_a = Residence times of ground water for an area

A_0 = Initial activity = 30 dpm/10^3 litres.

A = 0.018 dpm/ 10^3 litres

Half life = 105 years $= \dfrac{\ln 2}{\lambda_x}.$

$\Rightarrow \lambda_x = 6.6 \times 10^{-3}.$

$$\frac{A}{A_0} = e^{-\lambda_x T_a}$$

$$\Rightarrow \ln\left(\frac{A}{A_0}\right) = -\lambda_x T_a$$

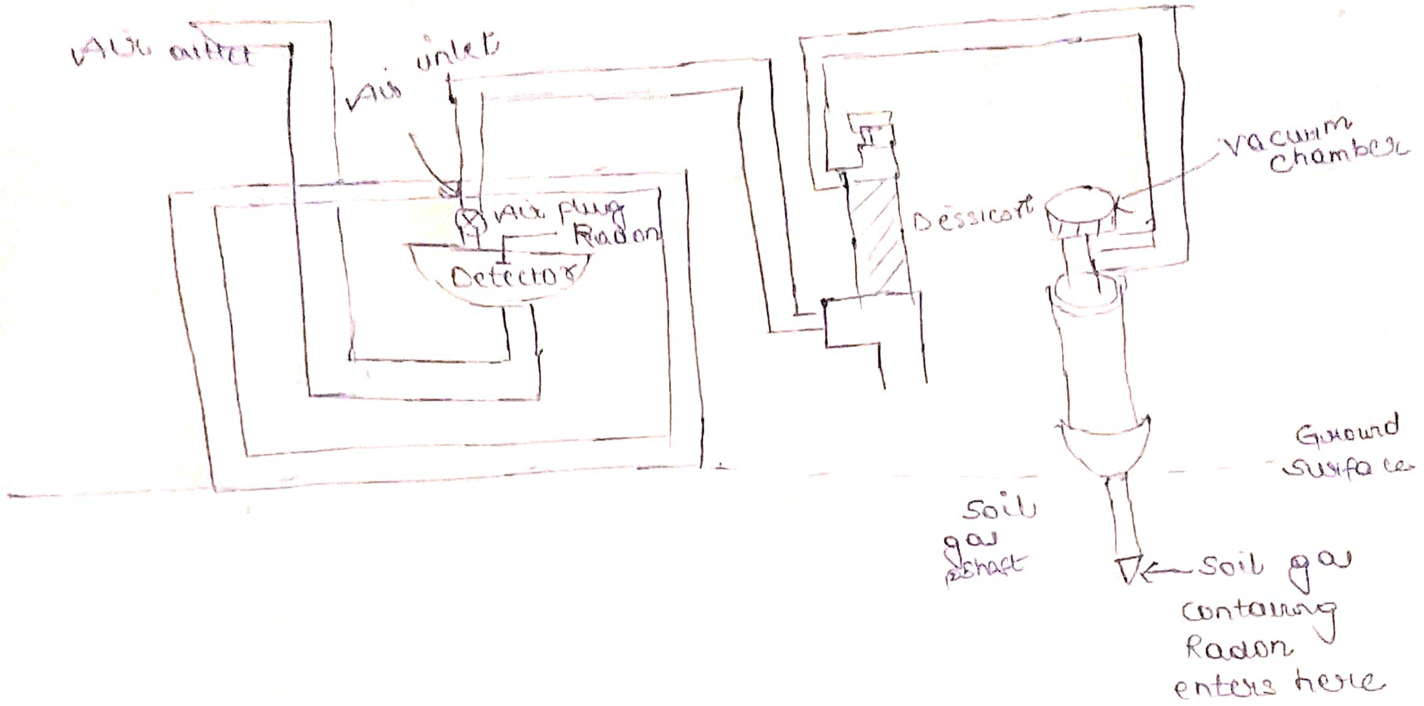
$$\Rightarrow T_a = \frac{-\ln\left(\frac{A}{A_0}\right)}{\lambda_x} = \frac{\ln\left(\frac{0.018}{30}\right)}{\lambda_x}$$

$$= 1.12 \times 10^3$$

$$= 1124 \text{ years.}$$

Residence Time = 1124 years.

(4) ~~Show~~ Schematic diagram for measuring Radon emanation from the subsurface



It is used as an earthquake precursor because
Radon is released from ~~cos~~ cavities and cracks
in the Earth's crust is obtained prior to
as the Earth's crust is Earthquake, so the
the sudden slip of an interior of
abnormal Radon exhalation from with earthquake
earth has been associated can
as it is a radioactive gas so it
be traced by detecting alpha ~~practices~~ particles
A common way to determine radon anomaly
is use of standard deviation. A reliable
radon anomaly is required because it is
often impossible to distinguish an anomaly
caused solely by a seismic event from one

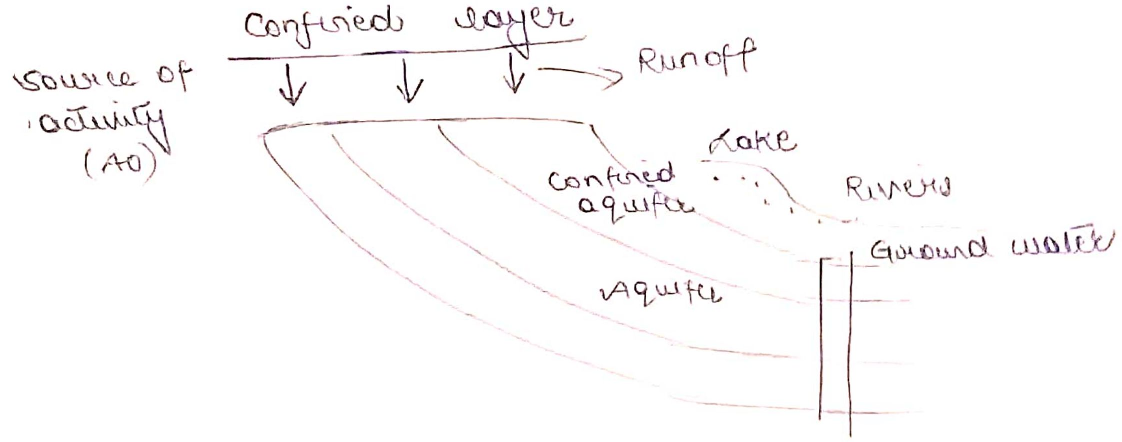
resulting from meteorological or hydrological parameters. Radon exhalation from soil can be obtained using three main approach.

- Direct in situ measurements.
- Estimation of radon flux density using models based on theoretical equations and on proxy data.
- Laboratory measurements of soil samples

Yes it is depth dependent.

No it would not provide a reliable near surface radon anomaly because it is near surface and more noise will be there.

(5) Ground water prospecting



ΔA = Recharge or value adaution.

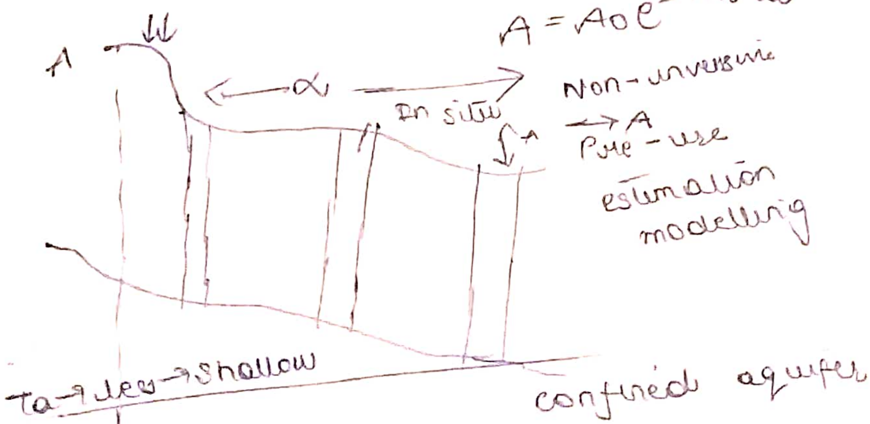
If aquifer is :- (i) Shallow - higher recharging
(ii) Deep - lesser recharging

Higher energy is better for α, β spectrometry
{better S/N ratio}

^{14}C is very good for deeper aquifer
Tracer nucloid.

Half-life - short → Shallow aquifer (<1000 years)

$$A = A_0 e^{-\lambda \times T_a}$$



↓
Frequent recharging

T_a = Apparent age (years)

A_0 = Initial activity of source $f x^n$ (dpm/l)

A = Measured activity

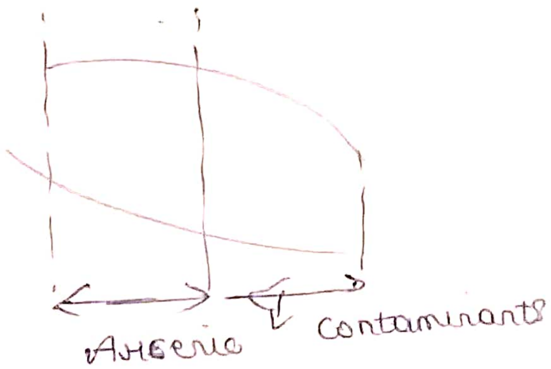
T_a = Residence Time

Recharge rate = $\frac{d}{T_a}$

Characteristic of ideal tracer

- Radionuclide should be firmly attached to the biological substance. It should not get dissociated in transit through the body
- The biological behaviour of the tracer should be identical to its stable counterpart.

Arsenic and fluoride contaminants are easier to study and contamination is more due to anthropogenic activities



(6) Uranium - Extraction and Exploration

$\boxed{\text{Uranium deposits}}$ → $\frac{\text{Net Count Rate}}{\text{Field back ground}} > 6$

depends on lateral extent and depth

Lateral extent → Determined by histogram method

^{235}U → Define
→ Nuclear reactors
→ n 0.12% - is isotopic abundance

Isotopic abundance of U is changed by chemical method

Depleted Uranium :- (i) Entire isotopic abundance is changed
(ii) Fission based reactor.

→ Remote controlled airborne method

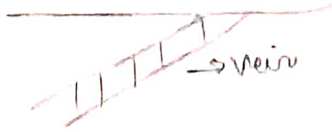
U^{235}/U^{238} is the ratio of 1/138 in Earth

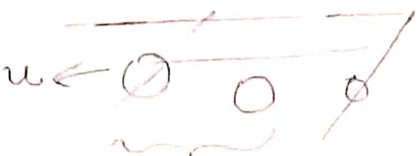
70% of energy in India.

Mining of Uranium deposits

(i) Extraction :-

Subsurface U mines





Excavation by Diamond drilling method during

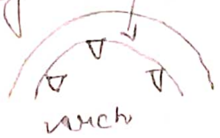
Gap to avoid slumping

Room and pillar method :-

- Done using Geiger counter

- Chemical etching
- Sent to nuclear industry

(ii) Disposal - Ore grade & ore recovery :-



Done by :- Scintillation detectors

- Transported and then graded and finally dumped or ores

Method :-

- RED LED (low) → Tailings pond ⇒ slurry
- BLUE (intermediate) → (b) compensate
- GREEN (high) → (c) dumped

Tailings pond should be dug in high resisting rock area. It may lead to ground water contamination.