Disclaimer:

This presentation is a part of the assignment for MSc III Semester Mineral Exploration theory paper. This is an attempt to enable the students to collect and review the literature, prepare powerpoint presentation and present the work, independently. The data and literature used here has been taken from various sources, and duly acknowledged. This can help as a guideline, and should not be treated as final.

October 2016

Radiometric Surveying

Presented by-

Name-jitendra kumar sahu

Msc 3 rd semester

Sos in geology and Wrm

Introduction

- Radioactive methods of prospecting are based on the measurement of the spontaneosly disintegrated alpha ,Beta,and gamma rays by radioactive material.
- The radioactive elements, constantly undergo a process of disintegration. During disintegration they emit radiation of three types

a) alpha rays
b) beta rays
c) gamma rays

of the three above said radiation, only the gamma rays are useful from the point of view of radiometric surveys due to its large penetration depth compared with alpha and beta radiation.

- **Radioactive minerals :**Uranium and thorium is highly radioactive. thus the occurrence of U and TH in rocks and minerals can be detected if radioactivity can be detected.
- Minerals containing zirconium, beryllium, niobium, columbium as well as the rare earth group e.g. cerium, lanthanum etc. will fall under this group which requires special detectors.

- A radiometric, survey measures the spatial distribution of three radioactive, elements viz potassium (K) , thorium (TH) and uranium (U) in the top 30-45 cm . of the earth crust.

2)What is radioactivity?

Radioactivity is the nuclear reaction of spontaneous decomposition. This means that an unstable nuclei decomposes into a more stable one while at the same time emitting radiations.

Radioactivity is caused by the disintegration of the atomic nucleus leading to the production of energy known as (α) (β) and (ϒ) rays.

of these three particles:

- alpha particles are of little use in prospecting because of there relative large size and little penetration power.
- beta particles have large velocity and greater power.
- gamma particles have large energy together with large frequencies. they have 10-100 times the power of penetration of the beta particles and can pass through about 1 foot of rocks. These are the most effective in prospecting for radioactive minerals.

What is radiometric?

Radiometric is a measure of the natural radiation in the earth surface, which can tell us about the distribution of certain soils and rocks. Radiometric is also known as gamma ray spectrometry.

Radioactive elements occur naturally in the crystals of particular mineral.

The abundance of minerals change across the earths surface with variations in rock and soil type. because the energy of gamma rays is related to the source radioactive element, they can be used to measure the abundance of those elements in an area.

So by measuring the energy of gamma rays being emitted in an we can infer the presence of particular minerals in the earth's surface.

Common terms used in radiometrics

- Isotope : An element whose atoms have a common number of proton and electron (i.e. same atomic number)but vary in the number of neutrons in their nucleus .

  example - Hydrogen exists in 3 isotopic forms - hydrogen (1p 0n), deuterium (1p1n),tritium (1p2n)
- Radioisotope :Radioisotopes are isotopes that are radioactive because they have unstable nuclei.
- Daughter isotope: The product which remains after an original isotopes has undergoes radioactive decay.
- Parent isotope : the original isotope is termed as parent isotope.

- Half life : The radioactive half life for a given isotope is the time for half the radioactive nuclei in any sample to undergo radioactive decay .After two half lives ,there will be one fourth the original sample .after 3 half lives one eights of the original sample and so on...

  Formula: t1/2 = log 2 /k =0.693/k

Instruments and its principle

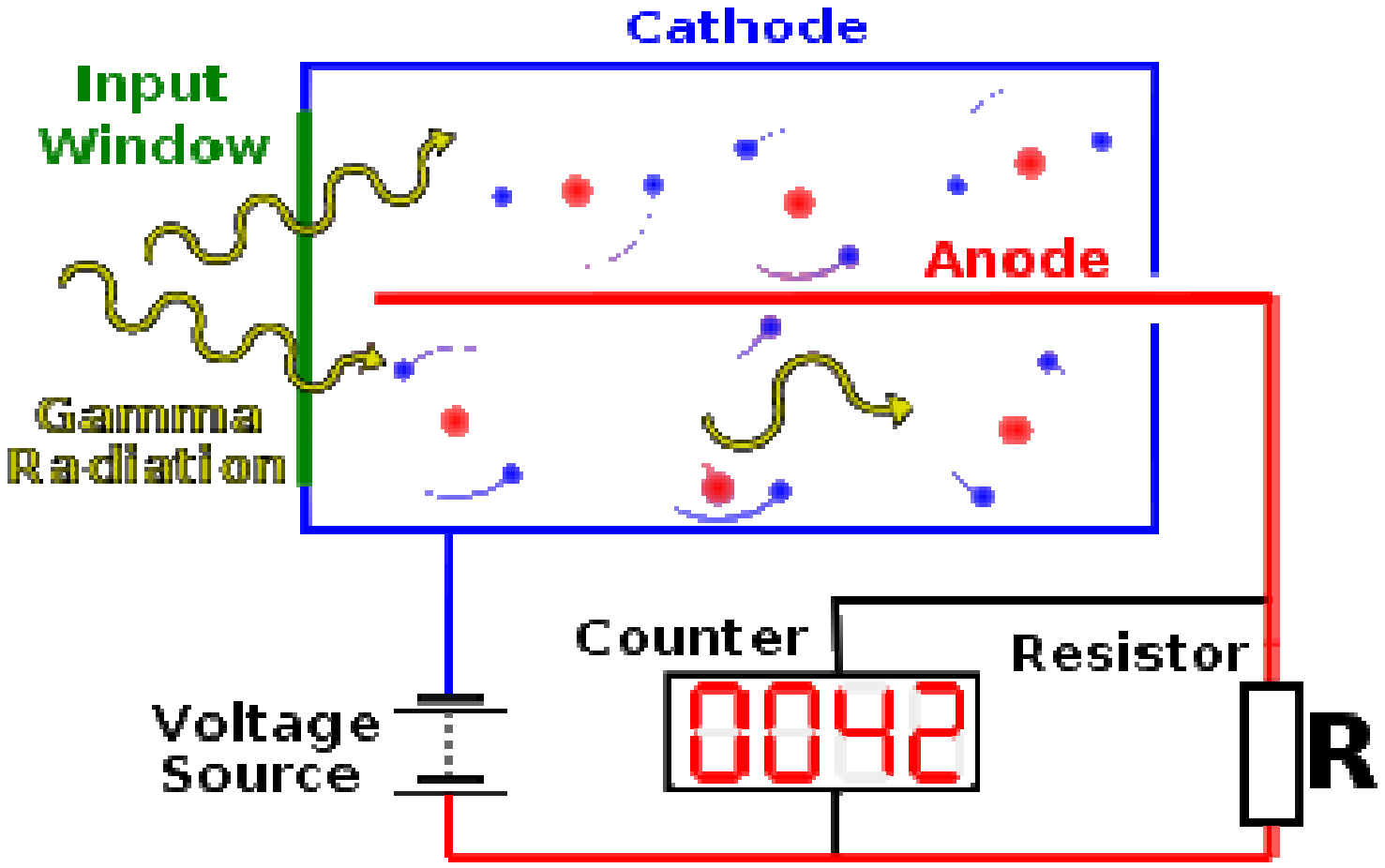
Various devices have been used for the detection of radioactivity one of the earliest was ionization chamber. at present there are mainly two instruments which are used for radiometric surveys.

1) Geiger Muller counter 2)scintillation counter

1) Geiger Muller counter

- The Gm counter was invented by Geiger in 1908 and Muller also took part in developing it further in 1928.
- The Gm counter creates an electric pulse when radiation interacts with a gas within it.
- It coverts and records the electric pulse into a radiation reading.
- Radiation is typically measured in counts per minute (cpm)

Diagram


Cathode
Input Window
Anode
Gamma Radiation
Counter
Resistor
0042
Voltage Source
R

Principle

- The principle of the GM counter is based on the fact that when atom collide with the high velocity radioactive particles ionization takes place and the presence of electron and proton so produce is detected.
- When the tube placed in an area where radioactivity is present ,radioactive emission enter the tube and collide with the atoms of inert gas within. Ions and electron and proton thus produced.
- The electrons acquire high acceleration and are attracted by the anode. The proton move towards the cathodes
- Electrons collide with other atoms and further ionization occurs . this process This process become continuous .
- Avalanches creates a pulse of electric current the pulse of current is amplified and counted electronically.

scintillation counter

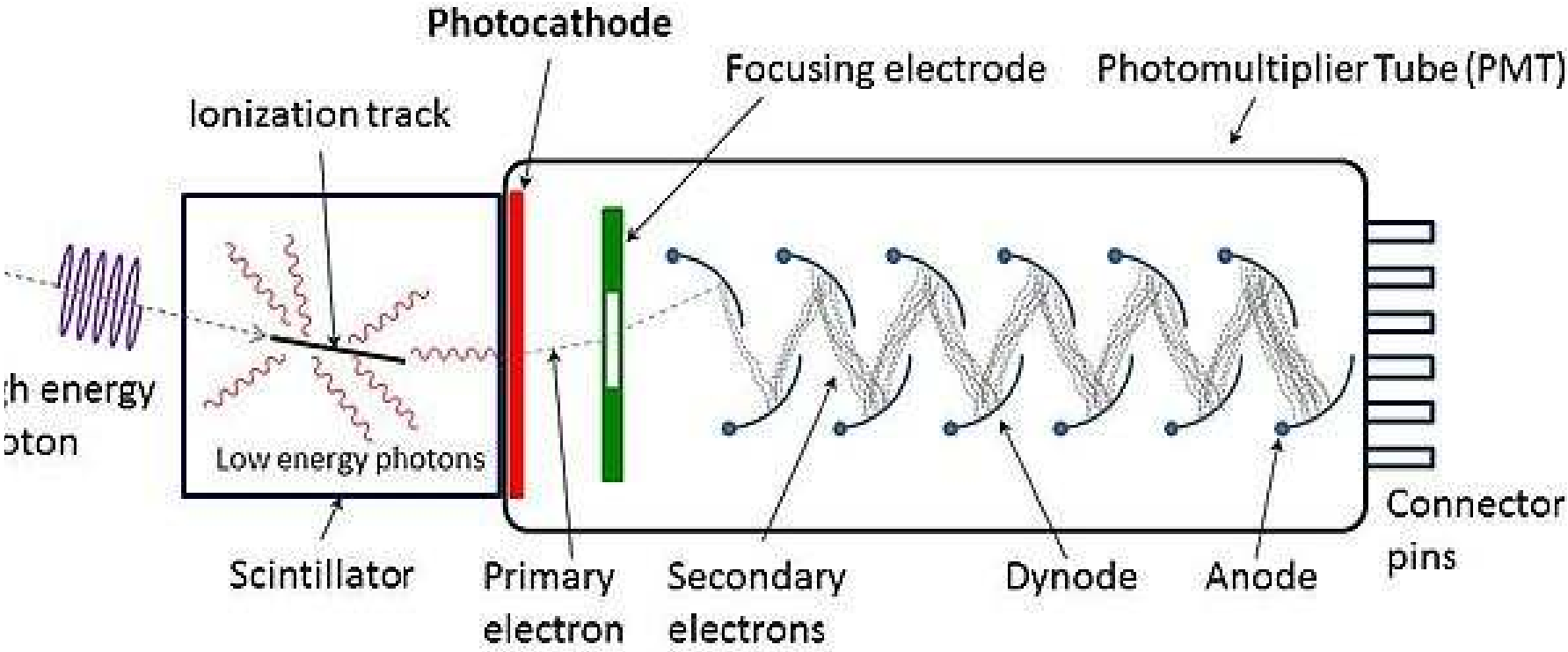
This is very sensitive instrument which measures the intensity of gamma rays in terms of electrical signals

A scintillation counter is an instrument for detecting and measuring ionizing radiation by using the excitation effect of incident radiation on scintillate material and detecting the resultant light pulses.

sc are so called since during their operation scintillation or minute flashes of visible light are produced, the intensity of which depend on the bombardment by radioactive emanations.

the sc employ certain substances like zns (zinc sulfide) or thallium activated sodium iodide crystals ,which emit visible light when struck by alpha beta and gamma radiations such substance are known as phosphorus.

Construction : It consists of a scintillate which generates photons in response to incident radiations . A sensitive photomultiplier tube (PMT) which coverts light to an electrical signal and electronics to process this signals


Photocathode
Focusing electrode
Photomultiplier Tube (PMT)
Ionization track
h energy
oton
Low energy photons
Scintillator
Primary electron
Secondary electrons
Dynode
Anode
Connector pins

PMT detector is attached to an amplifier and other electronic equipment to count signals.

PMT is made up of several electrode, known as DYNODE. whose potentials are increased in succession along the length of the tube

Flashes from the material is measured by photo multiplier tube.

principle:

- ✓ When a charge particle strikes the scintillator , its atoms are excited and photons are emitted
- ✓ These photons are directed at the PMT photocathode ,which emits the electron by photoelectric effect.

- ✓ These electrons focused by an electrical potential so that they strike the first dynode of the tube.
- ✓ The impact of a single electron on the dynode releases a number of secondary electrons which are in turn accelerate to strike the second dynode .
- ✓ Each subsequent dynode impact releases further electrons and so there is a current amplifying effect at each dynode stage.
- ✓ Each stage is at a higher potential than the previous to provide the accelerating field.
- ✓ The resultant output signal at anode is in the form of a measurable pulse for each photon detected at photocathode and is passed to processing electronics.
- ✓ The pulse carries information about the energy of the original incident radiation on the scintillate.

Types of radiometric survey

Depending on whether the measurements are made from air,at the ground or along drill holes the radioactive surveys are classified into three groups ::

1. Airborne radiometric survey
2. Ground radiometric survey
3. Radioactive logging of borehole

1) Airborne radiometric survey:

In airborne survey, scintillation counter are used for recording the gamma rays from the air .These surveys are usually carried out along with the aeromagnetic and aero electromagnetic surveys. By airborne radiometric survey the deposit of radioactive substance and boundaries between various rock type may be outlined.

2) Ground radiometric survey: In ground radiometric surveys,the GM counter is commonly used for detection of gamma rays emitted from the source may be used may be used to locate radioactive mineral. the ground radiometric survey are used mainly:

1. To search deposits of radioactive substances
2. To outline geological structure such as fault

3).Radioactive logging : The radioactive logging is an operation in which gamma rays count of various rock formation met in a borehole arebrecorde continuous along depth .This depth wise record is called radioactive log

the radioactive logging is used for....

1.correlating rock bed ..as a rule acid rocks are more radioactive than basic rocks .

2.For determining porosity....as a rule the radioactivity counts of different rocks vary with their ies.

Field procedures

a. In air borne survey the scintillation counter is employed and the speeds are 140-145 m.p.h while the altitude is about 600 feet above ground level.
b. Counters are employed in measuring radioactivity in bore hole
c. It is to be remembered that a ceryain amount of radioactivity can be produced by cosmic radiations as well as from the rocks containing radioactive isotoos ...such radioactivity which is ubiquitous is known as BACKGROUND RADIATION.
d. This background value is to be deducted from the value value of radioactivity as obtained from the meter.
e. The god leaf electroscope can be employed ,under suitable conditions .for locating fault zoned ,especially when mapping is required in connectiom with engineering investigation.

Occurence

Radioactive mineral occur in very low content in different rock type viz..

I. Magmatic or igneous rocks
II. sedimentary rocks
III. Metamorphic rocks of low grade.

I. In magmatic rocks they usually concentrate in acidic, plutonic rocks which include granitoids-pegmatite and volcanic rocks like rhyolites and acid tuffs ..

Radioactive minerals like monazite and zircon also occur in placer derived from such magmatic ro ks .Thorium mineral generally occur in acid igneous rock.

Amongst the sedimentary rocks , pyrite bearing quartz-pebble, conglomerates and phosphate and carbonaceous rocks are good host for uranium minerals.

In Metamorphic rocks of low grade like phyllite and schist.

Locality

Uranium. .

The uranium occurrences are spread over 180 km long singhbhum shear zone and imp deposits as follows...

1) jaduguda-Located in east singhbhum district, here the mineralization is associated with conglomerate and chlorite schist of singhbhum group.

2) Bhatin-It lies 2 km west of jaduguda along shear zone.The host rock for uranium mineralisation is biotite chlorite schist.

3)Turamadih-A cluster of deposits occur in proximity to each other at turamdih located nearly 20km west of jadguda

4) Narwapahar-It lies 10 km west of jaduguda along shearzone.the host rock for uranium mineralisation is chlorite -quatz schist

5) Uranium deposite also found in Alwar dist,Rajasthan and sikar dist ,rajasthan.

MONAZITE

In india monazite in the coastle tracts of cuttack and ganjam district of orissa where the thickness of placer is about 30 cm with a monazite contents of 2.5%

Minor occurence have been noticed between chilka lake and chicacole river also.

Thank you