Nuclear Geophysics Lab Assignment

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1. A graphic illustration of a hand-held radiometric survey is shown above. Gamma rays emitted by radioactive substances produce pulses of electric current in the tube which are indicated as readings of the meter. The geiger counter will record pulses even when it is not near uranium minerals or other radioactive materials. These pulses or “background count” are caused mainly by cosmic rays and by radioactive elements present in nearly everything on earth. This background count in first measured during prospecting. Wherever the counter registers 2 or 3 times the background count, the probe should be used and the source of radioactivity determined. One should determine whether the radioactivity is occurring from high-grade vein or from a mineral sparsely distributed through the rocks. A relatively large area of weak radioactive rocks will cause a response similar to that of a small pocket of high-grade ore.
   Since the mineral vein that is a source of radiation is situated in the south-east half of the segment, the nuclear count rate will be different for both North and South alignment. As a result, the count rate will be higher in the south and lower as we travel north.

2. The presence of radioactive materials in beach deposits is indicated by a high nuclear count rate in the coastal zone. Heavy mineral-rich beach sands, concentrated by wave and wind action, have been found to contain significant gamma radioactivity, due primarily to

trace amounts of uranium and thorium found in monazite and zircon. Concentrations of heavy minerals are found in beach berms and coastal dunes. The above isorad map indicates the presence of sources of enhanced level of natural radioactivity in the beach sands are found chiefly in monazite sands and to a lesser extent in zircons. In monazite crystal structure, Th concentration is more favoured than U in the actinide content. The enrichment of radiogenic heavy minerals in the beach placer deposits, are chiefly controlled by the local geological conditions, geochemical nature of the source rocks, degree of weathering, favourable geomorphology and humid tropical climate of the region.

The sediments may have been transported to the Bay of Bengal shore by the Mahanadi River drainage systems, where they enriched in a large volume of mineral sand deposit.

3. Gamma rays will be received from a 2 geometry if the detector is positioned on a flat surface of a uniform material that stretches to infinity in all directions around the detector. The greater the distance between a point source and the detector in this geometry, the lower the reported intensity. The attenuation gamma rays is controlled by the relationship

   $I = Io * e^{(-\mu x)}$

   μ - Absorption coefficient

   x - distance through with the gamma ray travels.

4. Large gamma-ray spectrometers weighing several kilogrammes may now be carried by heavy-duty unmanned aerial vehicles (UAVs). Moreover, they can be purchased at an affordable price. These large UAV-borne gamma-ray detection systems are used to map the naturally occurring radionuclides ^{40}K, ^{238}U, ^{232}Th. Such platforms have the advantage that they can be deployed over terrain that is difficult to access, while still maintaining a high spatial resolution. In contrast to UAV-borne radioactive pollution studies, the naturally

occurring radionuclides have a much lower activity and therefore require longer integration time, slower flying speed or a larger detector, in order to effectively determine the spatial radionuclide distribution. In hand held surveys, it takes much longer to get all readings and there may be terrains that are physically inaccessible. Handheld surveys, on the other hand, are inexpensive because drones are not required. Handheld surveys are typically used when a limited region has to be studied in depth.