

# Radiological Assessment of Black Powder in Sales Gas Pipelines

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## Introduction



Fig.1. Black powder produced during pipeline scraping

Black Powder is a generic term given to corrosion products which become entrained in the flow of sales gas in transmission pipelines producing erosion failure in valves, blocking of instrumentation and lowering the efficiency of process equipment. The constituent components of Black Powder have been reported to include iron sulfide, iron oxide and iron carbonate in various combinations with additional contaminants including salts, sand, hydrocarbons and metal debris [1].

To mitigate the operational impact of Black Powder, routine scraping of sales gas pipelines is carried out to remove debris from the internal surfaces of the pipelines. These scraping operations bring workers into contact with the Black Powder, which when removed from the pipeline system becomes an industrial waste.

Naturally Occurring Radioactive Material (NORM) is a byproduct of oil and gas production, with the progeny of radon, a particular concern in gas operations. A study to ascertain the extent and level of NORM in Black Powder debris from scraping activities associated with sales gas pipelines was established. The goals of which were to ensure that adequate protection was provided to workers recovering scrapers and handling Black Powder waste; the waste itself was disposed of in an appropriate manner.

## Sampling

The sales gas pipeline system is extensive and covers in excess of 4,000 km, traversing the Kingdom of Saudi Arabia. Engineered into the pipeline system are scraper launch and receiver stations to facilitate the maintenance, inspection and cleaning of the system. The receiver stations were used as locations to collect representative samples on the recovery of pipeline scrapers after cleaning operations. It was planned to sample 40 locations and that these should each be sampled three times, to determine levels of radioactivity present in Black Powder and attempt to ascertain any geographical, temporal or seasonal variations in radioactivity concentrations [2].

Operational constraints hampered the scheduled sample collection program; however, 63 samples from different locations throughout the system have been collected and analyzed, with complete results re-

ceived for 54 samples. Sampling of the system is continuing to enable full characterization of Black Powder in the sales gas pipeline system.

## Radiometric Analysis

The analysis was carried out utilizing the services of a national certified lab at King AbdulAziz University (KAU), Jiddah. The analysis of the Pb-210 and Po-210 required extensive method development to attain satisfactory analyte recoveries from the Black Powder matrix [3]. The main problem was to overcome the chemical interference of high levels of iron in the black powder acid extracts. The Po-210 method involved the deposition of polonium from dilute acidic solutions onto a silver disc, with the Po-210 determined using alpha spectrometry [4-6]. Two methods were identified for the determination of Pb-210, which decays by low-energy beta and low energy gamma (46.5 keV) emissions. The method of choice for the Pb-210 analysis involved liquid scintillation counting, which was found to be suitable for the low levels encountered and provided acceptable sample throughputs [3].

## Results

The activity concentrations of Pb-210 in representative samples collected are detailed in Fig. 1, and Po-210 in representative samples collected in Fig. 2.

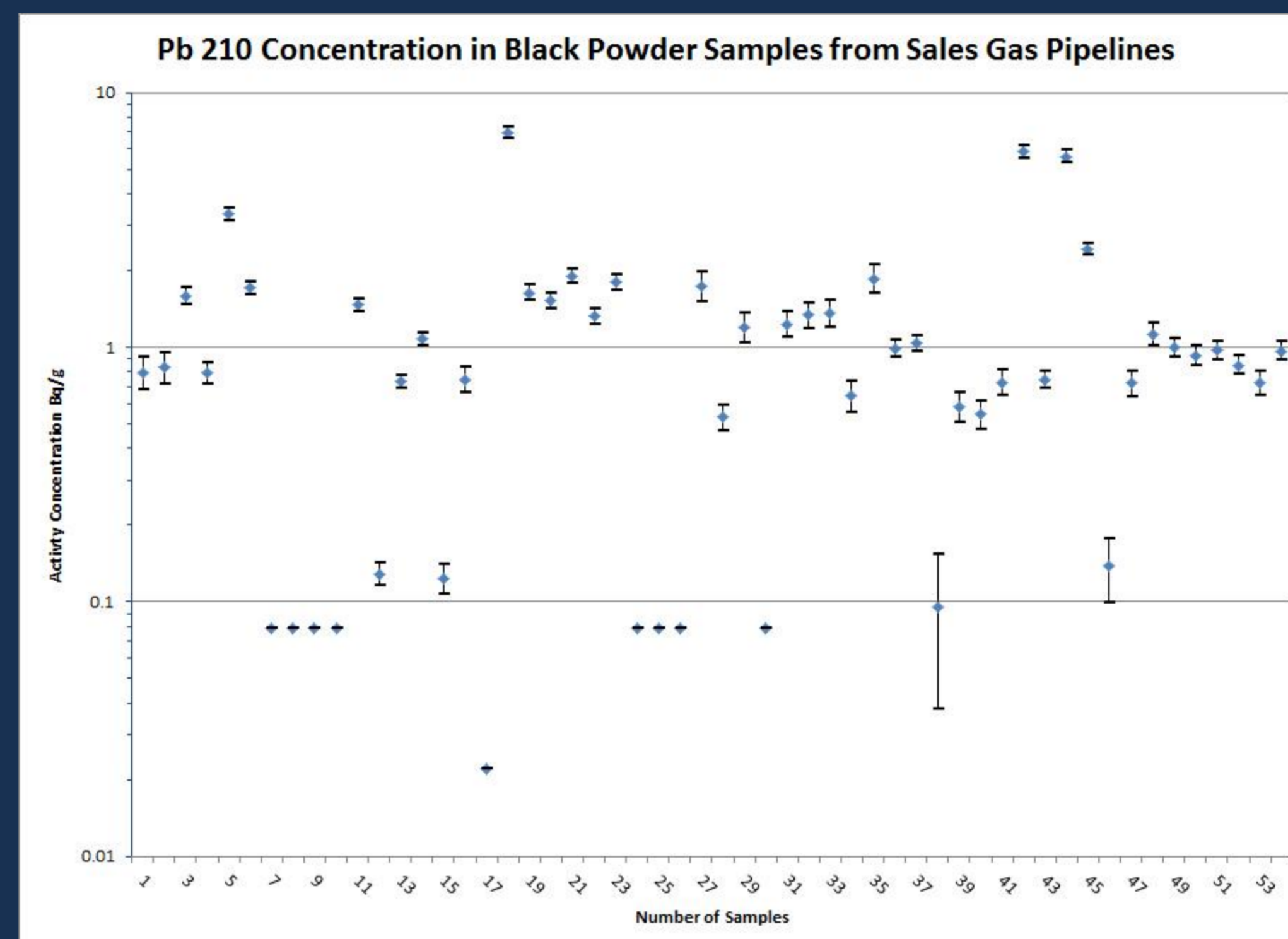


Fig.2. Pb-210 concentration in black powder samples

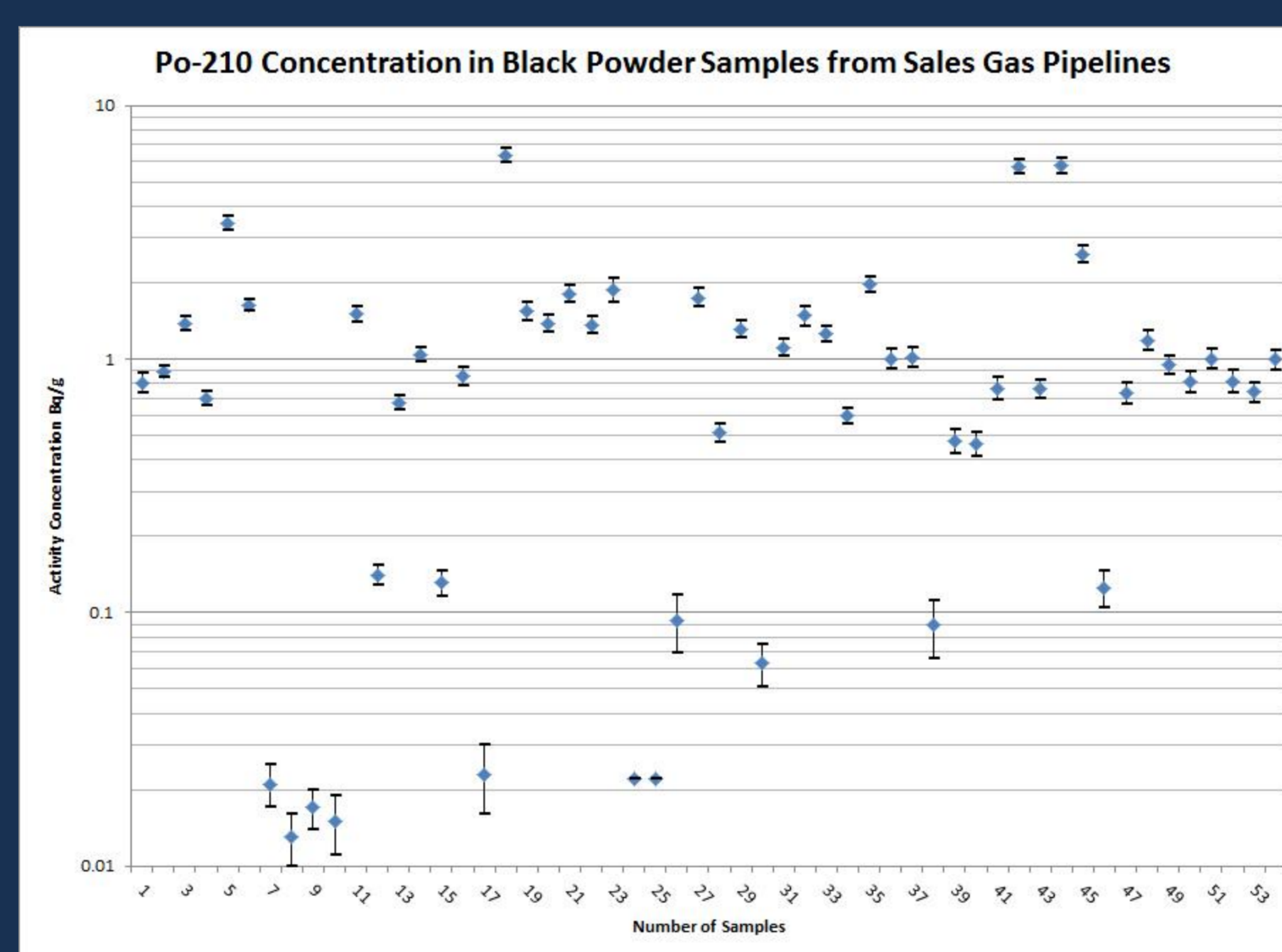


Fig. 3. Po-210 concentration in black powder

The results indicate that Pb-210 and Po-210 are in radioactive equilibrium (Fig.4.), which would require a time period in excess of 2 years.

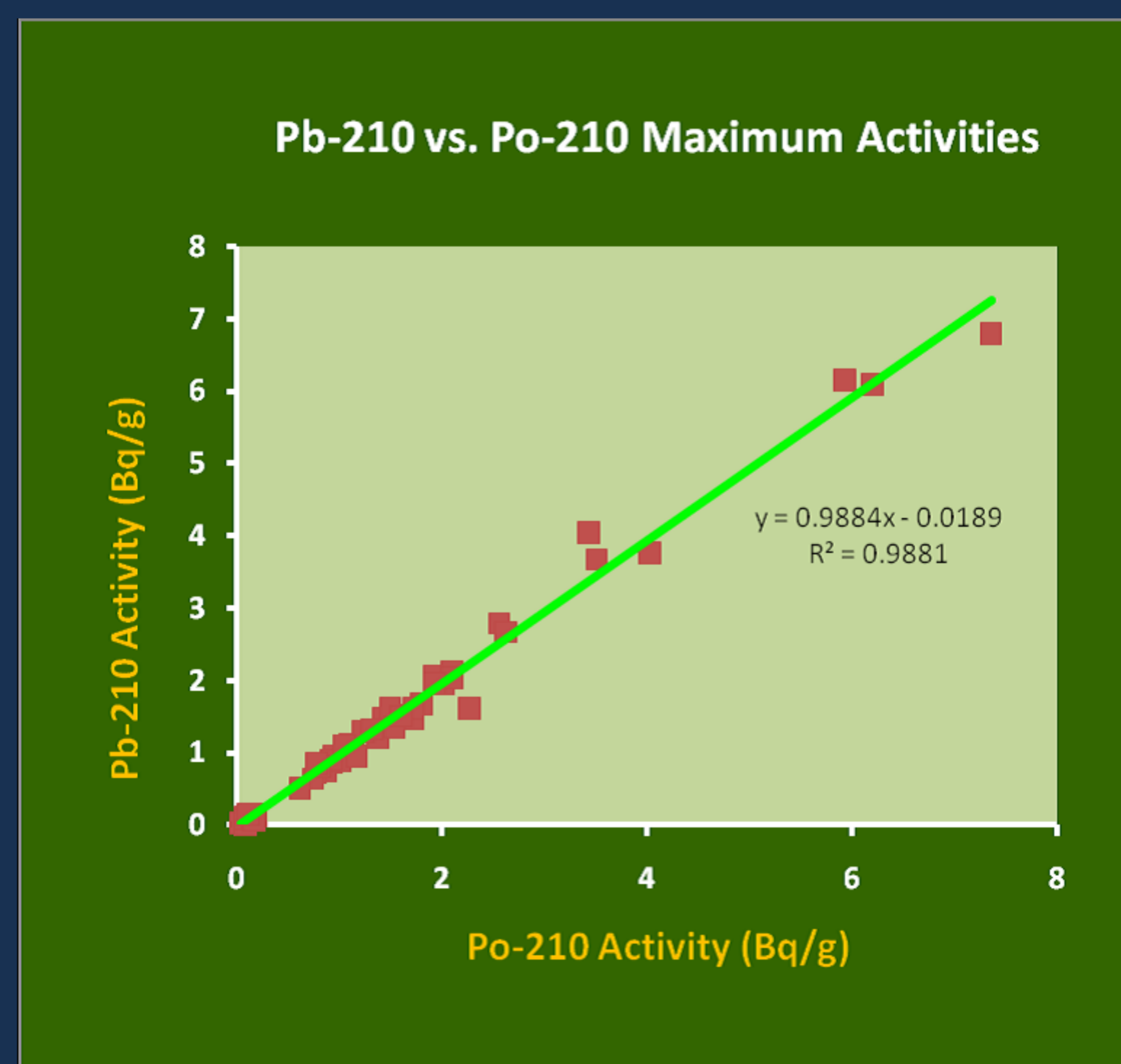


Fig. 4. Pb-210 versus Po-210 activity concentration

## Workers Protection & Contamination Control

Personnel required to work with Black Powder must be trained in the associated hazards.

- All Black Powder operations shall be covered by a safe system of work, which shall identify the hazards and highlight the precautions to be taken.
- Any item or area with detectable levels of loose Black Powder contamination shall be subject to radiological controls.
- Appropriate personal protective equipment (PPE) shall be worn



Fig.5. Worker recovering pipeline scraper

- All Black Powder operations shall be carried out in a manner which prevents the spread of Black Powder contamination and minimizes the potential for workers to be exposed to Black Powder.
- Black Powder operations shall only be undertaken in areas which are clearly demarcated and access is restricted to those directly involved in the operations.

Advice is provided that waste debris from scraping activities is required to be contained and stored in suitable receptacles pending its status being determined [7]. If found with negligible levels of radioactivity, it can be disposed off with normal hydrocarbon waste streams. If found with enhanced levels it will be stored and disposed in a controlled manner with other wastes containing enhanced levels of natural radioactivity.

## Conclusions

1. Enhanced levels of Pb-210 and Po-210 have been detected in the Black Powder samples collected.
2. Pb-210 and Po-210 appear to be in secular equilibrium in the samples analyzed.

## References

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