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SOLUBILITY OF URANIUM COMPOUNDS AT URANIUM MILLS

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The solubility of yellowcake (and the radioactive isotopes in uranium ore and tailings) is currently being measured under contract to the NRC by Battelle-Pacific Northwest Laboratories. Solubility is being measured in simulated lung fluid at body temperature using a pass-by method for yellowcake and a batch-method for ore samples. The discussion below is taken from Battelle's first progress report to the NRC.

Figure 1 shows the solubility for an ore dust sample collected from the air in the crushing plant of a New Mexico mill. Note that uranium shows a surprisingly short 35-day dissolution half-life. On the other hand thorium-230 and lead-210 do not show measurable dissolution. About 20% of the radium-225 appears to dissolve rapidly, but the remaining 80% shows little solubility. According to the ICRP Task Force Lung Model uranium would be a class W compound, thorium-230 and lead-210 would be class Y, and radium-226 would be 20% class W and 80% class Y.

Figure 2 shows solubility of yellowcake from three mills. The Exxon sample was green-black, the Kerr McGee sample was orange-yellow, and the Anaconda sample was green-yellow. Dissolution half-lives of 8.5 days, 13.7 days, and 24 days were measured.

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According to the ICRP Task Force Lung Model the two more soluble yellowcake samples are on the borderline between classes D and W. The less soluble yellowcake is nearer class W (50-day half-life, by ICRP definition). These results should be considered preliminary, and may be revised at a later date.

An analysis completed by R. E. Alexander of the NRC Office of Standards Development indicates that for any natural uranium compound with a half-life of 50 days or less in the lung, chemical toxicity to the kidney is the critical consideration. This analysis, along with the dissolution half-life results obtained at Battelle-Pacific Northwest Laboratories, have led the NRC staff to take the position that yellowcake should be considered soluble with respect to compliance with § 20.103 of 10 CFR Part 20. It is possible that a similar position will be taken later for uranium ore dust, depending on future results obtained for the dissolution half-life.

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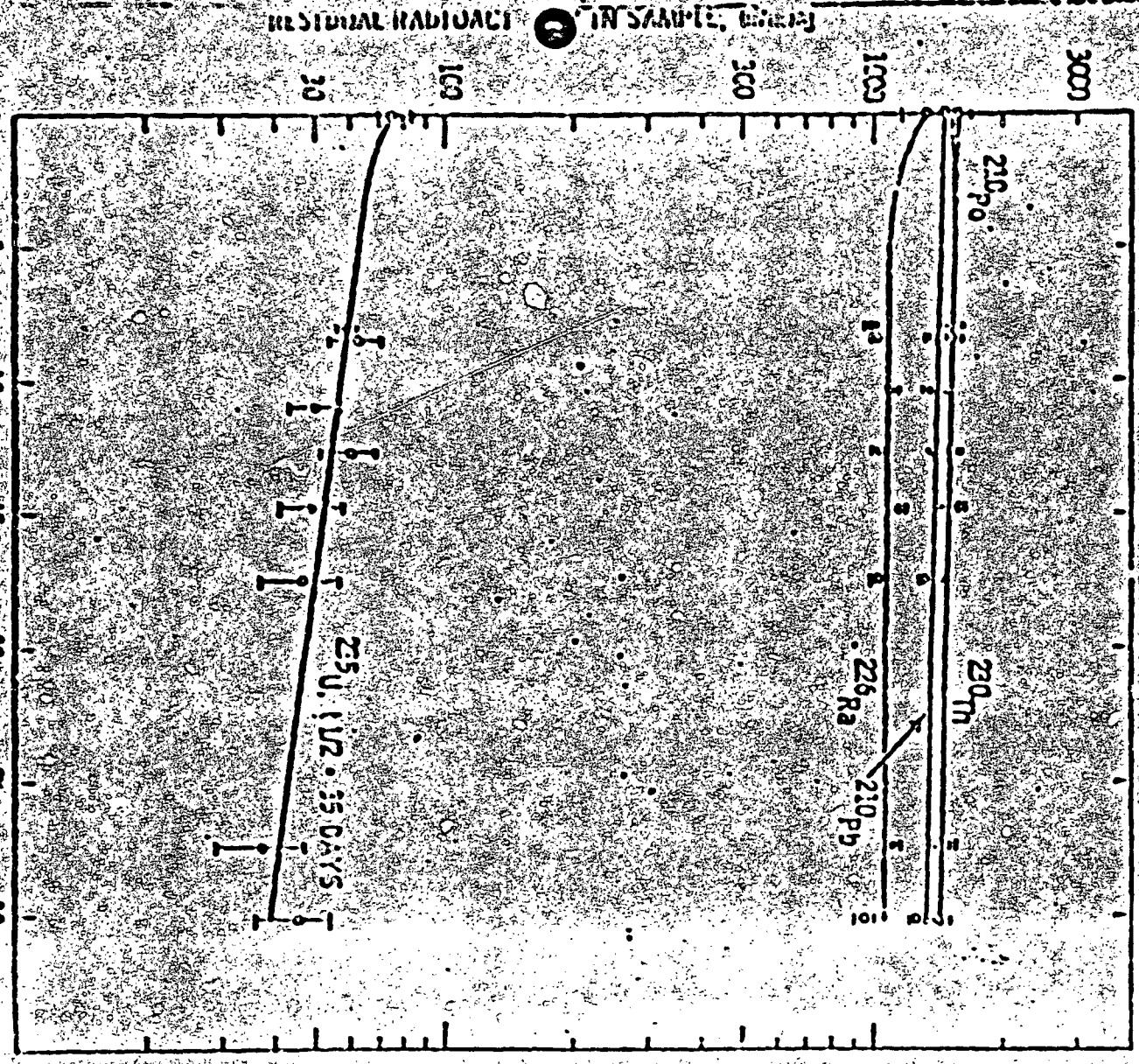

FIGURE 1. AMOUNTS OF UNDISSOLVED RADIONUCLIDES REMAINING IN ORE-DUST SAMPLE 2551-19-4 AS A FUNCTION OF THE TIME EXPOSED TO SIMULATED LUNG FLUID AT 37°C. OPEN AND FILLED CIRCLES DISTINGUISH DATA FROM SUSPENSIONS STORED IN POLYETHYLENE OR PYREX GLASS, RESPECTIVELY. THE CONFIDENCE INTERVALS ARE ±1 STANDARD DEVIATION.

FIGURE 2. AMOUNTS OF UNDISSOLVED ^{238}U REMAINING IN YELLOW-CAKE SAMPLES AS A FUNCTION OF THE TIME EXPOSED TO SIMULATED LUNG FLUID AT 37°C AND FLOWING THROUGH THE DISSOLUTION CHAMBER AT A RATE OF 472 ML PER DAY. THE CONFIDENCE INTERVALS ARE ± 1 STANDARD DEVIATION.

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