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-226 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.

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.

Acknowledgements: The experimental results were obtained at Battelle-Pacific Northwest Laboratories under the direction of Dr. Donald Kalkwarf. Al Breslin, Andreas George, and Ronald Knuth of ERDA's Environmental Measurements Laboratory collected the ore dust sample, and Mr. William Shelley of Kerr-McGee supplied the yellowcake samples.

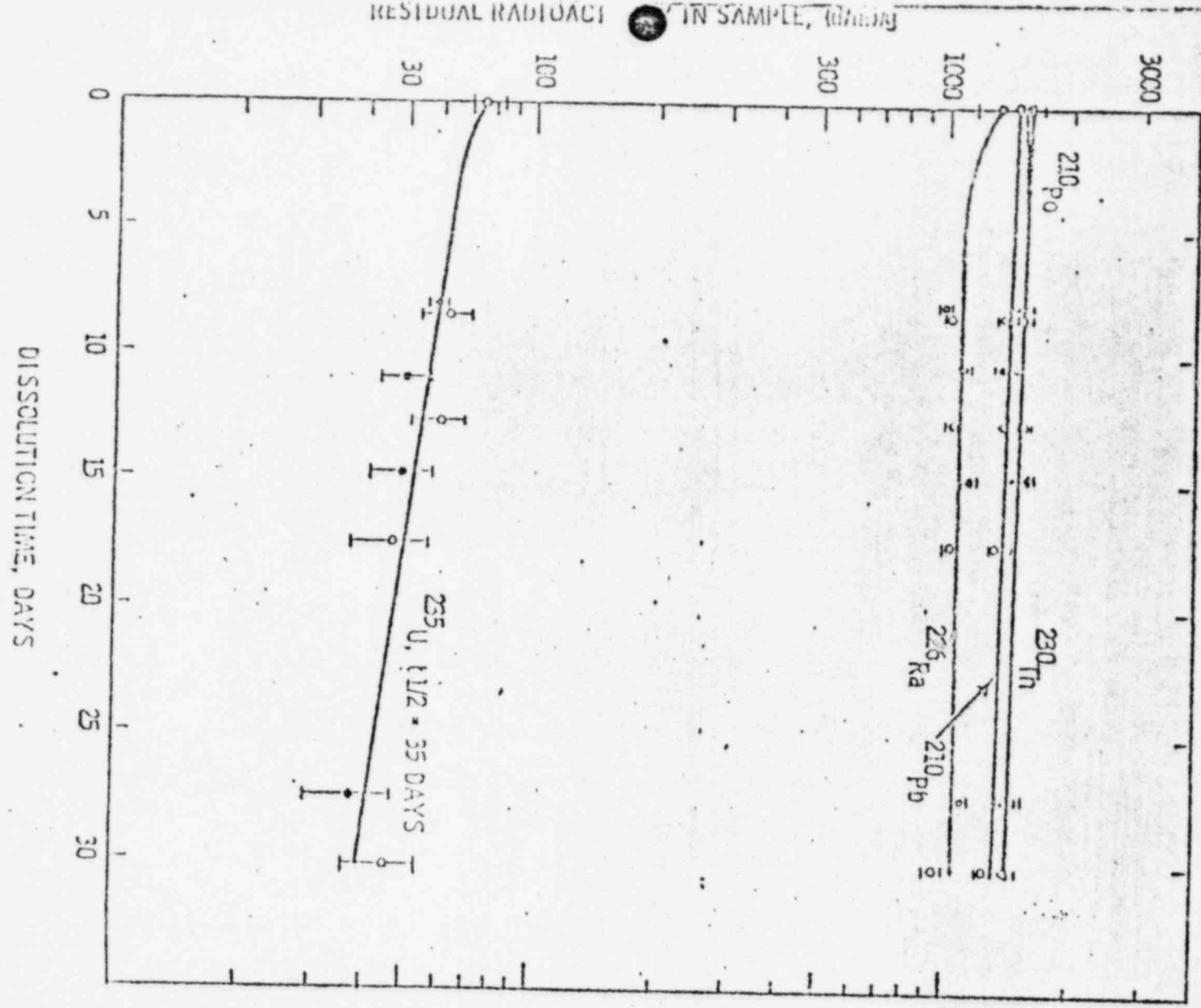

FIGURE 1. AMOUNTS OF UNDISSOLVED RADIONUCLIDES REMAINING IN ORE-DUST SAMPLE 2551-19-4 AS A FUNCTION OF THE TIME EXPOSED TO SIMULATED LUNG FLUID AT 37°C. OPEN AND FILLED CIRCLES DISTINGUISH DATA FROM SUSPENSIONS STORED IN POLYETHYLENE OR PYREX GLASS, RESPECTIVELY. THE CONFIDENCE INTERVALS ARE ±1 STANDARD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

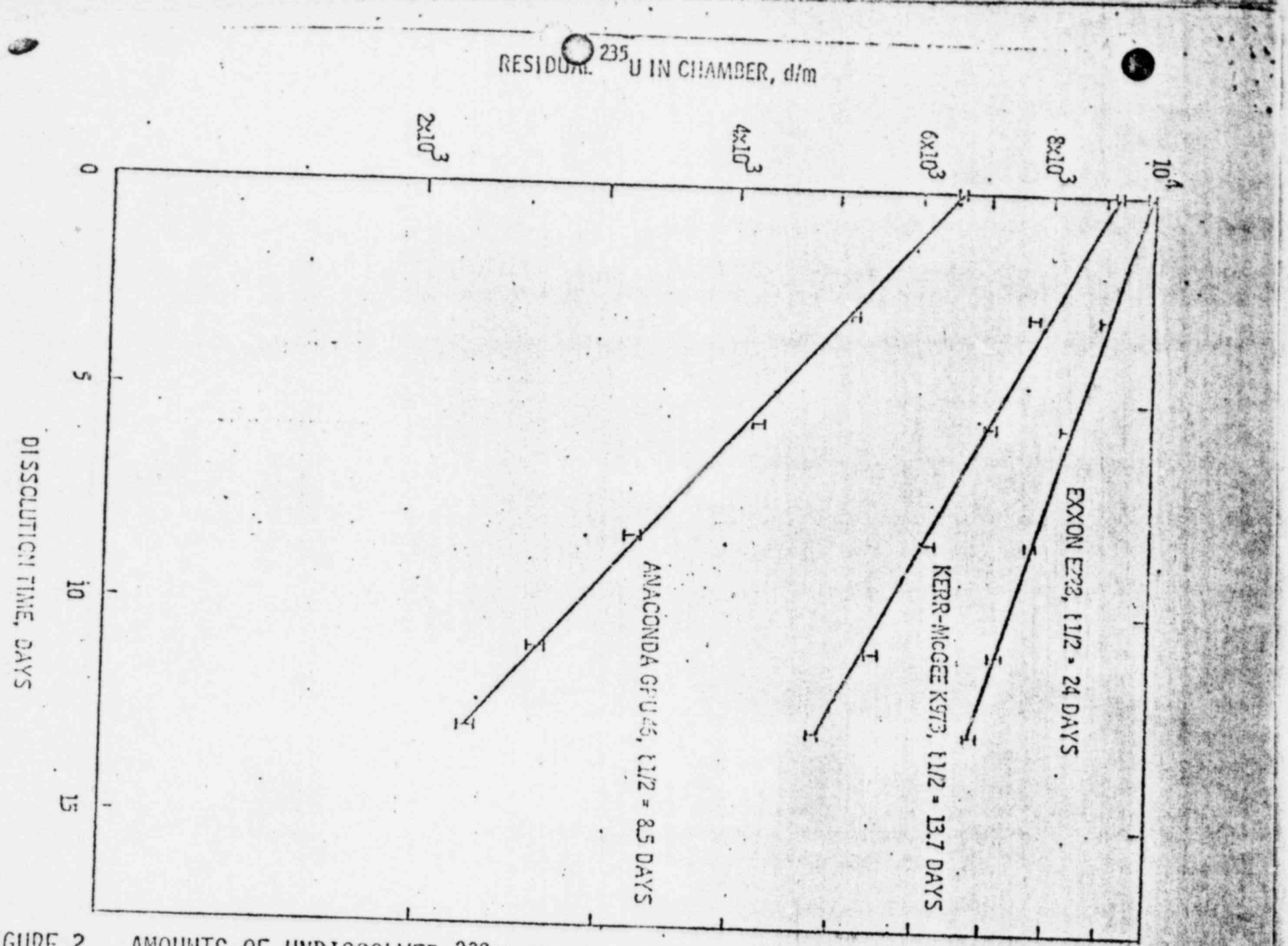

FIGURE 2. AMOUNTS OF UNDISSOLVED ^{238}U REMAINING IN YELLOW-CAKE SAMPLES AS A FUNCTION OF THE TIME EXPOSED TO SIMULATED LUNG FLUID AT 37°C AND FLOWING THROUGH THE DISSOLUTION CHAMBER AT A RATE OF 472 ML PER DAY. THE CONFIDENCE INTERVALS ARE ± 1 STANDARD DEVIATION.

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