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MINES BRANCH INVESTIGATION REPORT IR 62-47

# NEUTRON ACTIVATION ANALYSIS OF TWO ORE SAMPLES SUBMITTED BY DR. R. H. WRIGHT, VANCOUVER, B. C.

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MINERAL SCIENCES DIVISION





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## SUMMARY OF RESULTS

Two ore samples, submitted by Dr. R.H. Wright of the B.C. Research Council on behalf of Mr. R. Fraser, have been assayed for gold by neutron activation analysis. By means of a Texas Nuclear neutron generator with a thermal flux of about $10^8$ n/cm$^2$/sec and spiked samples as internal standards, it was found that the submitted samples contained less than 10 ppm gold.

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## INTRODUCTION

At the request of Dr. R.H. Wright, of the British Columbia Research Council, two samples of ore, submitted to him by Mr. R. Fraser of Vancouver, have been assayed for gold content by neutron activation analysis. Sample 1 was a sample of the crushed ore screened through an 8 mesh screen, while Sample 2 was a concentrate made from the ore. The orebody from which the sample was obtained was reported to be a schistose argillite containing fairly abundant carboniferous material. Conventional analyses of the samples had given rather wide discrepancies in gold values, which were thought tc arise from sampling errors or from heating the sample during chemical analysis. In neutron activation analysis a fairly large sample may be used,which is maintained at room temperature so that the method is free from these possible errors.

## METHOD

Thermal neutron activation of gold produces gold-198, which decays with a half-life of 2.7 days, predominantly by the emission of a 0.41 MeV gamma-ray. Examination of gold-containing samples with a multi-channel gamma spectrometer, following neutron irradiation, allows the gold to be characterised by this gamma-ray energy and to be confirmed by half-life measurements.

The neutron source used in this work was a 150 kV Texas Nuclear neutron generator which produces fast (14 MeV) neutrons by bombarding a tritium target with deuterium ions. These fast neutrons are slowed down to thermal energies (0.025 eV) by using water as a thermalising medium. Satisfactory thermalisation is achieved using a moderating distance of approximately two inches.

## TEST DETAILS

The two samples were irradiated in separate runs and were contained in three plastic vials, each of 35 ml capacity, placed in positions of comparable neutron flux in the water moderator surrounding the target. The total weight of Sample 1 in the three vials was 178.9 g and for Sample 2 the total weight was 62.8 g. Following irradiation, the contents of the three vials were placed in a plastic cup, shaken well, and the gamma-ray spectrum examined periodically for a number of days with a 100-channel gamma-ray spectrometer.

A continuous record of the neutron flux received by the samples was obtained by measuring the output of a boron trifluoride neutron counter mounted on the shielding wall around the generator. The reading of this counter is directly proportional to the neutron output of the generator. All samples were run for 40 minutes and received the same integrated neutron flux to within $\pm$ 5%.

In order to ascertain the lower level of gold that could be determined by this method, fractions of the two samples were "spiked" with a known amount of gold by adding an aliquot of a $KAu(CN)_2$-$2H_2O$ solution to each sample, drying and mixing thoroughly. The resulting gold concentrations were 50 ppm for Sample 1 and 240 ppm for Sample 2. These samples were irradiated in the same manner as the "unspiked" samples.

## GAMMA-RAY ANALYSIS FOR Au-198

Of the four activated samples, 1 and 2 were samples as received and 1S and 2S were the same except that a known quantity of gold had been added. All were examined periodically during their radioactive decay with a gamma-ray spectrometer having a 2 in. x 2 in. cylindrical sodium iodide crystal as the detector. Gamma-ray spectrograms were obtained covering energies up to 1000 keV, which were displayed in 100 channels. The principal peak due to Au-198 (412 keV), therefore, centred near channel 41.

The use of duplicate samples, 1S and 2S, to which gold had been added, served several purposes: (1) the spectrometer was calibrated quantitatively in relation to a given neutron irradiation as to relative sensitivity to gold in parts per million for Samples 1 and 2; (2) the energy scale of the spectrometer was calibrated at the precise point of interest; and (3) the most favourable time was determined during the decay process to look for gold in the natural samples relative to the unwanted background from the other activated elements.

Because Au-198 decays with a half-life of 2.7 days, it is reasonable to expect the gold peak gradually to become relatively more prominent in the spectrogram after several hours, when most of the shorter-lived interfering activities have decayed away. The optimum time for measurement was not sharply defined, but was found to be at least 3 days after irradiation, as shown in Figure 1; after a few further days any relative increase in sensitivity to gold would be offset by its lower activity, with a resultant decrease in statistical accuracy.

The spectrograms shown in Figures 2 and 3 indicate that 3 to 4 days after irradiation a gold content of 10 ppm would have been readily visible in Samples 1 and 2. A valley rather than any suggestion of a gold-peak was in fact observed, which indicates that the gold content of both samples submitted was less than this value.

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HPD:JLH/DV

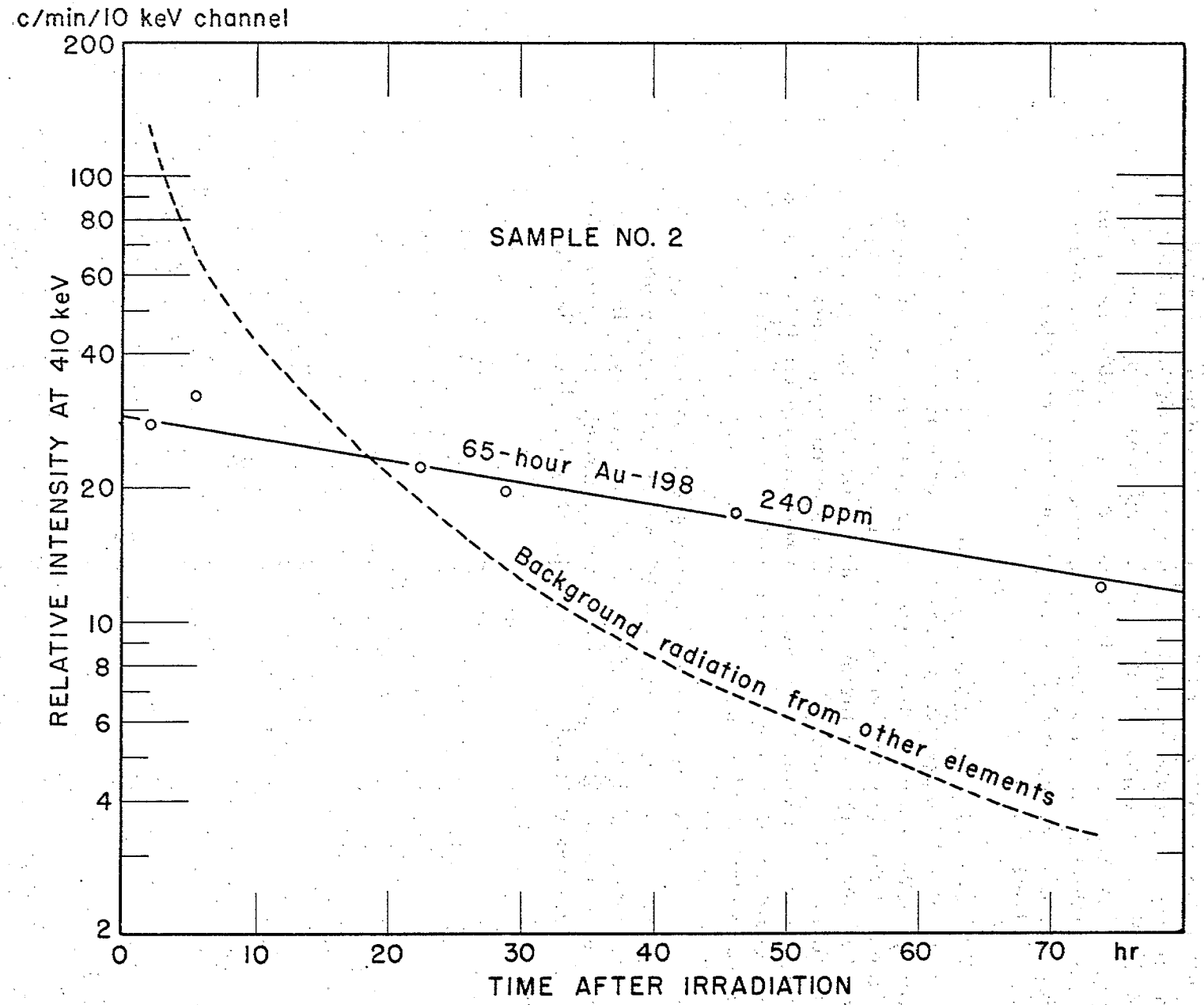


FIGURE 1 DETECTABILITY OF Au WITH DECAY TIME

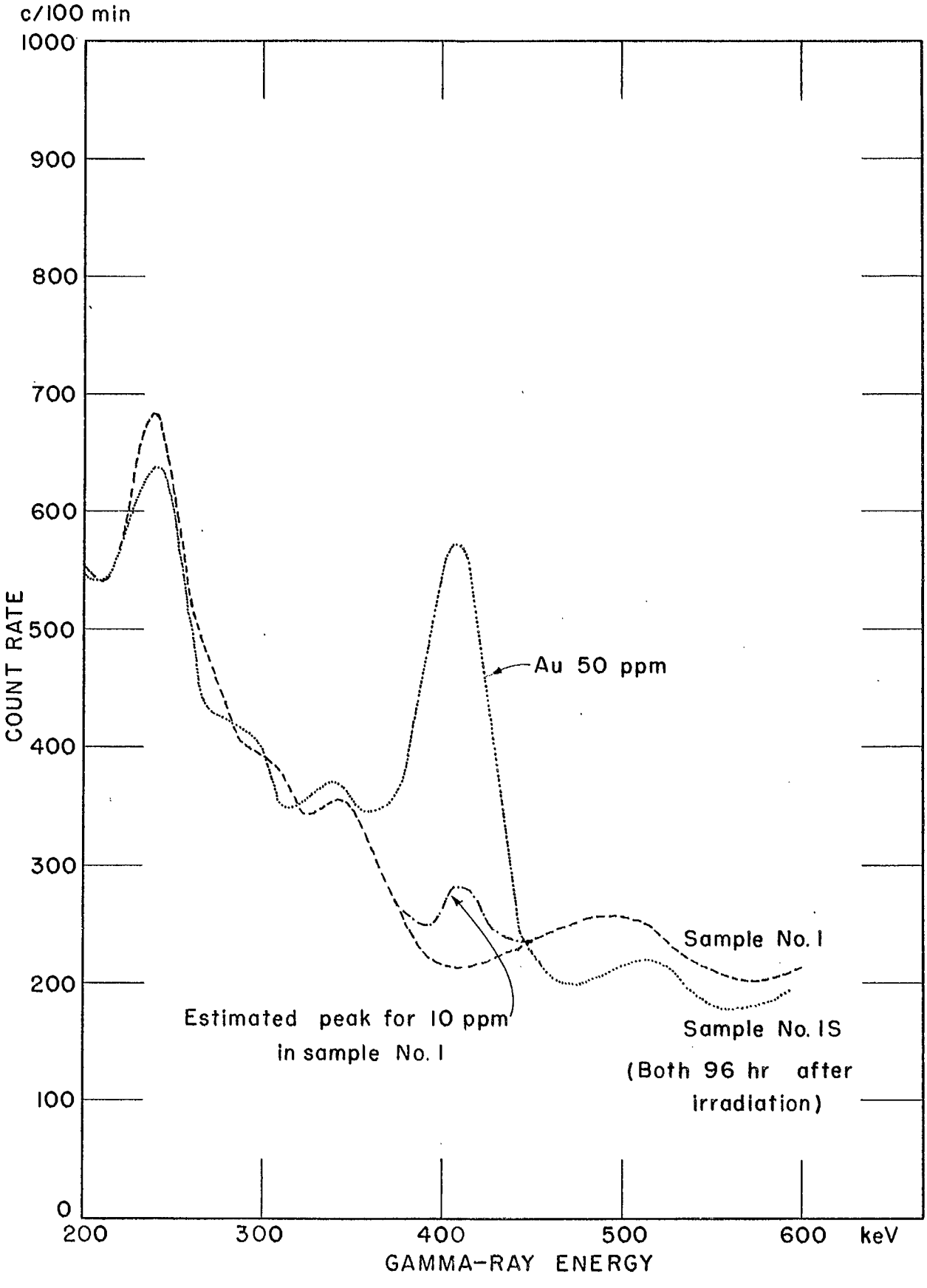


FIGURE 2 SPECTROGRAMS OF SAMPLES I AND I-S

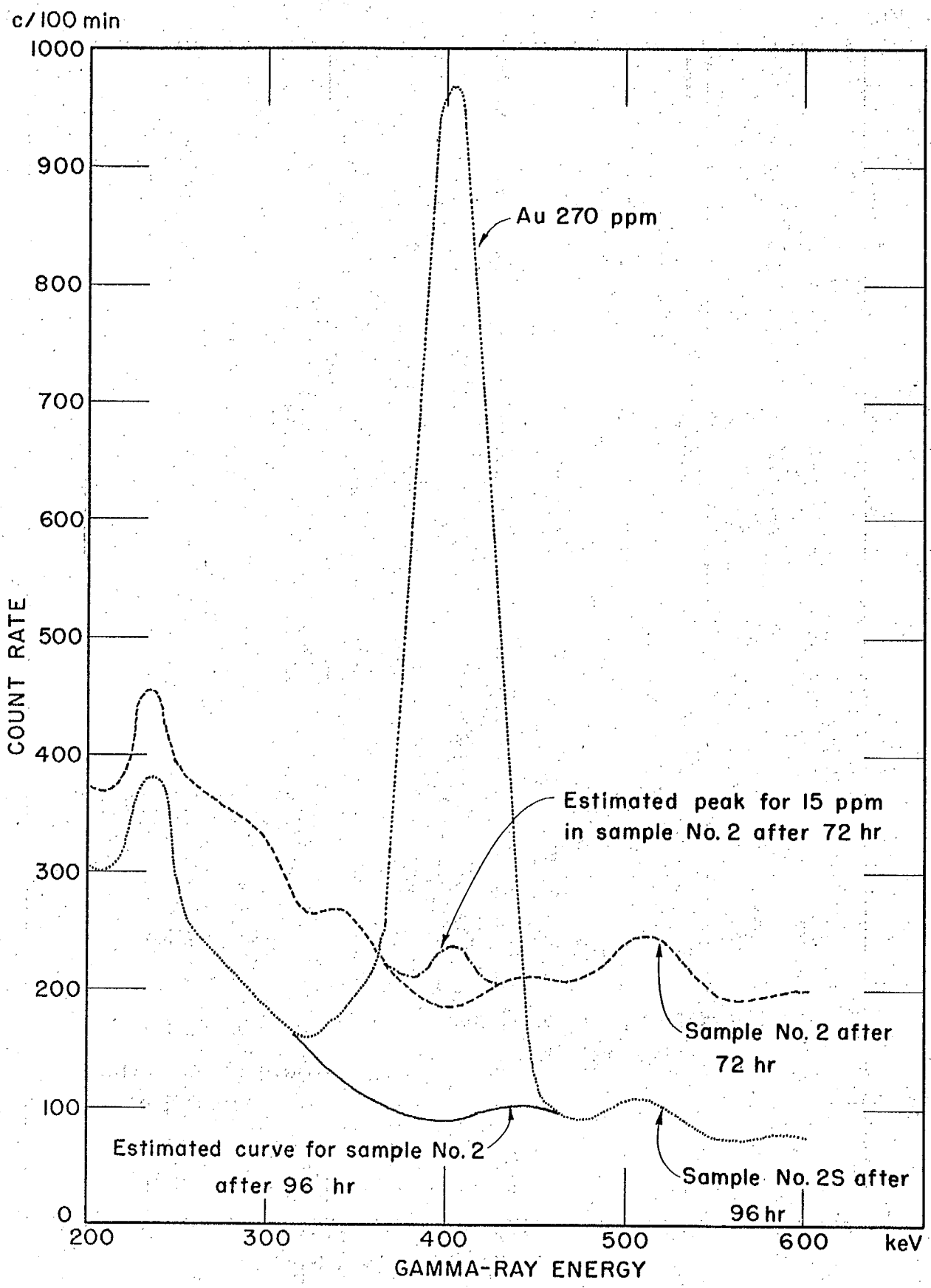


FIGURE 3 SPECTROGRAMS OF SAMPLES 2 AND 2-S