times in the upper and lower San Pedro basins, after correcting the measurements for the groundwater chemistry, were greater than 12,000 years. The ^{14}C data show the presence of a regional confined aquifer, a closed hydrological system and a locally extensive unconfined aquifer, an open system. ^{14}C, ^{3}H, δD and $\delta^{18}O$ depict areas of recharge, discharge, mixing and direction of flow. The ^{14}C groundwater ages do not increase in a downvalley direction, the assumed direction of groundwater movement in most of the intermontane basins in the region. Recharge to the confined aquifer in the lower San Pedro basin is from precipitation falling on the Galiuro Mountains along the eastern part of the valley. Recharge occurs along the entire mountain front near the alluvium-mountain contact and, subsequently, as groundwater flows normally to the axis of the mountains and discharges along the center of the basin. Where the aquifer is unconfined, recharge to the groundwater occurs over a much larger area of the basin with increasing mixing in the direction of flow. The hydrogeological concept of the isotope model is fully supprted by the water chemistry and by the reactions and associated mass transfer defined by the chemical model. Weathering of primary silicate minerals also does not increase in a downvalley direction but along the direction of flow.

PULSE-HEIGHT ANALYSIS FOR GAS PROPORTIONAL COUNTERS

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Pulse-height analysis can be combined with conventional gas proportional counting of radiocarbon to provide: 1) reduced background levels; 2) more sensitive monitoring of gas purity and plateau slope effects; 3) detection of radon contamination; 4) improved evaluation of guard counter performance, etc. I have investigated the performance of a prototype PHA system in the underground Menlo Park laboratory (cosmic-ray flux 0.28 cpm/cm^2) using a low-cost microcomputer (80286-16) to collect pulse-height spectra from four counters simultaneously. I found that 15–20% of the background pulses lie above the end-point of the ^{14}C spectrum. Variations in gas multiplication were monitored via the cosmic-ray spectrum, which exhibits a pronounced peak corresponding to the energy deposited by a meson crossing the diameter of the counter tube. The position of this peak is used to adjust the ^{14}C window in the anticoincidence spectrum. This procedure was found to reduce the plateau slope of a counter with S_0 = 44 cpm from 0.75%/100 volts to 0.2%/100 volts. About half of the excess pulses in a gas sample containing radon were found to lie above the ^{14}C window, allowing the detection of radon. The measurements also revealed a possible defect in the guard counter array, as two counters showed an imprint of the cosmic-ray spectrum in their background ^{14}C spectra. It will be of interest to compare these results with measurements done in a ground-surface laboratory.

CARBONATE CONTAMINATION REVISITED

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Bard *et al* (1990) have recently presented a set of uranium series disequilibrium dates on a stratigraphic sequence of previously radiocarbon dated coral samples (Fairbanks 1989). The authors present the hypothesis that the discrepancies between the two sets of dates contain information on the history of radiocarbon secular variations. These data can also be interpreted in light of a simple model of carbonate contamination (Robinson 1980, 1981). The model suggests

incorporation of radiocarbon from a source close to modern by a first-order rate process. The possible values of the rate constant were evaluated from the population of carbonate dates obtained by the Menlo Park laboratory during the first few years of its operation. Although the dating limit imposed by the apparatus was about 52,000 years, carbonate materials from a variety of environments yielded a maximum age of about 40,000 years. In certain less favorable situations, the maximum ages obtained were only in the 25,000–30,000-year range. Unfortunately, coral samples were not available for inclusion in the data set used to calibrate the model. A contamination rate constant that would give a limiting age of about 30,000 years well reproduces the radiocarbon *versus* absolute (U/Th) age variations in the Bard/Fairbanks data. Unfortunately, these workers did not attempt to measure the contamination in their corals (by radiocarbon dating the last interglacial samples). Perhaps the background levels available at their laboratory were not sufficiently low to make this feasible.

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RADIOCARBON DATING OF PREHISTORIC ROCK PAINTINGS

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Prehistoric pictographs occur worldwide, but until recently, they could not be dated directly. We have developed a new method that allows direct ^{14}C dates to be obtained on these artifacts. The technique is applicable even to paintings that occur on limestone ($CaCO_3$) walls. Preliminary work has been done on a pictograph from the Lower Pecos region of southwest Texas. A sample of the painting, which had spalled from the shelter wall by natural processes, was subjected to a low temperature (<150°C) oxygen plasma to selectively remove the organic carbon-containing material used in the paint without contamination from the limestone substrate. The primary product of the plasma reaction is CO_2, which was isolated and converted to graphite. The Zürich ETH accelerator mass spectrometer was then used to determine the ^{14}C content of the sample. An age of 3865 ± 100 BP was obtained, and is in good accord with the archaeological context, which has set the range between 2000 and 6000 BP. This technique is applicable to rock art samples which incorporated organic matter into the paint binder or vehicle. This preliminary result indicates that the method is feasible and can be used on rock art worldwide.

25 YEARS OF RADIOCARBON DATING SOILS: A PARADIGM OF ERRING AND LEARNING

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Soil organic matter sequesters about three times the carbon existing totally in the living biomass and nearly the same regarding the total carbon in the atmosphere. Using models, such as Jenkinson's and, presently more widely used, Parton's Century Model, soil organic matter fractions of different functions are defined, based on their ^{14}C ages. Rejuvenation of soil carbon was