and debris layers vary in horizontal extent and thickness, apparently as a function of hurricane strength, overwash height, and wind and current direction in relation to the source of sand supply and lake morphometry. In Lake Shelby, sand layers deposited in the center of the lake appear to be related to hurricanes of at least Class 4 or 5 strength.

A 9 m core retrieved from Lake Shelby spans the last 4800 years. It contains 50 cm of organic lake sediments overlying 8.5 m of clay. Sand and debris layers are present in the upper 3 m of the core. They are especially frequent and massive between 215-315 cm, perhaps recording an episode of more frequent or stronger hurricanes along the Gulf Coast. Another major hurricane event, recorded in the transition between gyttja and clay in all cores, changed Shelby from a lagoon to a lake approximately 2000 years ago.

Dating of storm deposits in a series of cores provides important proxy data on hurricane frequency useful for testing climate models.

Nº 16335

AN INDEPENDENT EVALUATION OF THE POTENTIAL PRECISION AND ACCURACY OF ROCK-VARNISH CATION RATIO DATES.

BIERMAN, Paul R. and GILLESPIE, Alan R., Department of Geological Sciences, University of Washington, Seattle, WA 98195

Chemical analyses, field observations and statistical calculations indicate that the accuracy and precision of chemical analyses, the uncertainty of calibration, and the chemical heterogeneity of rock varnish limit the applicability and certainty of rock-varnish cation-ratio (CR) dates.

Independent analysis of synthetic glass analogs of varnish by ICP, XRF, PIXE, SEM/EDS and SEM/WDS shows that the CR, [Ca+K]/Ti, is similarly determined by all methods except PIXE, the method used for most published CR determinations. Blind replicates showed that although PIXE analyses are precise (CR, $1\sigma < 5\%$, n=5), they are inaccurate unless Ba and Ti x-rays are accurately deconvoluted. Analysis of the synthetic varnish shows that most published CRs appear to include an uncertain percentage of Ba which may invalidate or significantly change dates based on these analyses (c.f. Harrington et al., 1989). This finding also removes the rationale for "cation leaching," the untested model previously assumed (Dorn, 1982 and 1989) to explain systematic changes in CRs with age.

CR dates can be no more certain than the calibration curve from which they are generated. Reanalysis of published data, using regression equations which consider the uncertainty in both CR measurements and in the age of calibration surfaces, indicates that the more rigorous, two-error method generates larger uncertainties than those previously published.

Rock varnish on a geomorphic surface is chemically heterogeneous as the result of environmental variables (Dorn, 1989) and weathering of rock substrate. Our observations suggest that chemical variability decreases as larger areas of varnish are included in a single analysis; however, if varnish chemistry differs with time, variability will increase as the sampled area becomes large enough (>100 cm^2?) to include varnish of different ages, e.g. if varnish is inadvertently sampled across the boundary of an ancient and visually undetectable spall.

Nº 18841

MAJOR FACTORS AFFECTING SOIL DEVELOPMENT IN THE TYPE BULL LAKE AND PINEDALE GLACIAL DEPOSITS, WIND RIVER RANGE, WYOMING.

SHROBA, Ralph R., U.S. Geological Survey, MS 913, Box 25046, Federal Center, Denver, CO 80225; HALL, Robert D., Department of Geology, Indiana University-Purdue University Indianapolis, 425 University Boulevard, Indianapolis, IN 46202

In an investigation of 18 soils formed in the type Bull Lake and Pinedale glacial deposits at Fremont Lake and Bull Lake in the Wind River Range of western Wyoming, we determined that the age of the till parent materials is likely to be the chief factor affecting soil development in these deposits and that climate, texture of the till parent materials, surface erosion, and possibly eolian influx are also important factors.

In both areas, soil morphology is better developed and there is more total clay and more total calcium carbonate in soils formed in deposits of Bull Lake age (about 140-150 ka) than in those formed in deposits of Pinedale age (about 20-35 ka). In deposits of both Bull Lake and Pinedale age, soil morphology is better developed at Fremont Lake than at Bull Lake, probably because the climate is wetter and cooler at Fremont Lake. In deposits of Bull Lake age, the total clay content of the soils is higher at Fremont Lake than at Bull Lake; in deposits of Pinedale age, it is lower. For the deposits of Bull Lake age, the total clay content may be controlled mainly by climate; for those of Pinedale age, it may be controlled mainly by the slightly finer texture of the till parent materials at Bull Lake. In deposits of both ages, the total calcium carbonate content of the soils is higher at Bull Lake than at Fremont Lake, probably because of the warmer and drier climate and the presence of limestone in the till parent materials at Bull Lake. Most of the soils at Bull Lake have been truncated by deflation and probably by other erosional processes; those at Fremont Lake do not appear to be truncated. Grain-size data suggest that eolian influx is not a major factor in the development of the non-carbonate fraction of the soils that we examined, although it may account for much or all of the secondary calcium carbonate in the soils in the two areas.

Nº 21145

CATION-RATIO DATING OF ROCK VARNISH: WHY DOES IT WORK?

RENEAU, Steven L., RAYMOND, Robert, Jr., and HARRINGTON, Charles D., Earth and Environmental Sciences Division, MS D462, Los Alamos National Laboratory, Los Alamos, NM 87545

Cation-ratio dating of rock varnish is an empirical method for estimating the age of geomorphic surfaces based on apparent changes in the varnish cation ratio (K+Ca):Ti [VCR] with time. Independent workers using a variety of methods have replicated the general trend of decreasing VCR with increasing surface age first presented by Dorn and Oberlander (1981). This trend was proposed to be due to the relative mobility of cations in varnish. By analogy with weathering rinds, K and Ca were presumed more mobile than Ti in varnish, with the progressive decrease in VCR over time interpreted as a preferential leaching of K and Ca.

We have examined elemental distributions in 49 line profiles through 15 varnish cross sections from 5 Cima volcanic field lava flows (age = <20 ka to ca. 460 ka), including over 3600 micron-scale analyses. No evidence exists for systematic changes in VCRs with depth in varnish or with surface age, or for significant preferential elemental mobility within varnish. Instead, the distributions of minor elements in varnish strongly reflect primary varnish stratigraphy as defined by the elements Mn, Fe, and Si. In general, K is associated with Si, Ca with Mn, and Ti with Fe. Variations in VCR within a varnish coat typically reflect the stratigraphy rather than depth or varnish age. In addition, no systematic changes with depth or age are seen in the ratios K:Si or Ca:Mn as would be expected if K and Ca are being preferentially leached from varnish. Clearly, alternative hypotheses are needed to explain the empirical correlation of VCR and age.

Of several hypotheses that have been examined, the one most consistent with available data from Cima and other areas is that the empirical trend of decreasing VCR with increasing surface age is a consequence of the incorporation of varying amounts of substrate into varnish analyses. With all VCR aquisition methods reported to date, some substrate is unavoidably included in most analyzed samples. Since the ratio (K+Ca):Ti is generally greater in substrates than in varnish, incorporation of substrate into analyses usually increases calculated VCRs. The relative importance of this addition of substrate should vary inversely with average varnish thickness, with a higher percentage of substrate included in analyses of younger, thinner varnishes than in older, thicker varnishes, consistent with the trend of decreasing VCR with increasing age.

Nº 21148

AN AMORPHOUS MANGANESE PHASE WITHIN ROCK VARNISH

RAYMOND, Robert Jr., BISH, David L., GUTHRIE, George D., RENEAU, Steven L., and CHIPERA, Steve J., Geology and Geochemistry, MS D469, Los Alamos National Laboratory, Los Alamos, NM 87545

Scanning electron microscope/energy dispersive x-ray (EDX) element line profiles traversing rock varnish cross-sections demonstrate a strong positive correlation between Ba and Mn, suggesting the Mn-bearing component of rock varnish is not the Ba-free mineral birnessite, $(Na,Ca,K)Mn_7O_{14}\cdot 3H_2O$, as suggested by earlier researchers. Although the correlation between Ca and Mn is less well-defined due to the occurrence of multiple Ca-bearing phases, a positive correlation between Ca and Mn also exists. Examining Mn-enriched, Si-poor rock varnish with transmission electron microscope (TEM)/EDX analysis confirmed the positive correlation between Mn, Ba, and Ca, but also showed a positive correlation between these elements and Fe, Al, and P within an amorphous phase, as defined by dark-field imaging, occurring as particles with cross sections as great as 2 μm in diameter. Mn commonly comprises greater than 20 wt% of rock varnish within a groundmass composed of clay phases readily identifiable by X-ray diffraction (XRD). However, no crystalline Mn phase can be identified by XRD using either Cu or Fe sources and count times up to 100s/0.02°2θ step. Considering the abundance of Mn in rock varnish and the TEM determination of a non-crystalline Mn phase, it seems unlikely that the absence of X-ray diffraction lines for a crystalline Mn mineral can be explained by small particle size. Unless other authigenic phases can be shown to unequivocally occur in rock varnish, defining geochemical parameters of rock varnish formation based on authigenic mineralization will only be possible after Eh-pH conditions of formation of the amorphous Mn phase are defined.

Nº 22587

RADIOCARBON DATING A POSSIBLE YOUNGER DRYAS IN U.S. ROCKIES

DAVIS, P. Thompson, Dept. Natural Sciences, Bentley Coll., Waltham, MA 02154-4705; ZIELINSKI, Gregory A., Dept. Geology, George Mason Univ., Fairfax, VA 22030

The Younger Dryas (YD) cold episode, dated about 11-10 ka, is a reversal in the general climatic warming during late Wisconsin / late Weichselian deglaciation and is primarily