magnetic types: ferromagnetic (Mt-series) and paramagnetic (Ilm-series) granites. In Ilm-series, AMS fabrics are controlled by both ilmenite and the ferromagnesian minerals. The magnetic fabrics have no relationship to the primary layering and are therefore considered as geologically meaningless. In the Mt-series, AMS fabrics are controlled by magnetite and display a weak sub-horizontal foliation parallel to the compositional layering and no obvious lineation. A number of samples > 50 however is necessary to reveal a lineation trend. These new AMS data on the Bushveld Mt-bearing anorogenic granites are consistent with in-situ crystallisation of a granitic magma which had a low crystal load at the time of emplacement. This also suggests that, in the absence of syn-magmatic regional deformation, AMS fabrics of ferromagnetic granites fail to record magma flow lines.

5:00 PM Lopez de Luchi, Monica

GRAVIMETRIC STUDY OF THE RENCA BATHOLITH, ARGENTINE: PRELIMINARY DATA

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A gravity survey of the Renca Batholith (NE Sierra de San Luis, Argentina) was performed in order to determine its shape at depth. The batholith is an 270 km2 elliptical zonal pluton with sharp contacts against medium grade metamorphic rocks. The main facies are an outer porphyric biotite-hornblende granodiorite to monzogranite, associated with amphibole-biotite monzonitic rocks and an inner equigranular biotite-muscovite monzogranite.
A 89 gravity stations-net, covering the whole pluton and its surrounding country rock, was tied to stations over the existing high-precision leveling lines. located. A LaCoste and Romberg gravity meter with a reading accuracy approximately to 0.01 mgal was used. After correction of the raw gravity date, the Bouguer anomaly values were calculated assuming a reduction density of 2.67 g/cm3. A residual anomaly gravity map was obtained.
Residual gravity anomaly map shows a high amplitude, 25 mgal and a gradient of 5mgal at the contact between the pluton and its country rock except for the west margin. Lowest values, -5 to -15 mgal are roughly coincident with the inner equigranular unit. Values for the outer zone are either positive or negative. Positive values up to 10mgal are located preferentially at the westernmost part of the west half which could be the result of both the higher density of the monzonitic rocks and a thinner granitoid layer. Negative values up to -10mgal are characteristic for the eastern portion of the porphyric outer zone and may be explained by considering a higher thickness in this area which agrees with the previous structural and petrological information which points to shallower erosion levels in the eastern half of the batholith.

SESSION 180, 01:30 PM

Wednesday, November 15, 2000

T46. Advances in Quaternary Geochronometry II (GSA Quaternary Geology and Geomorphology Division; American Geophysical Union)

Reno/Sparks B4

1:30 PM Granger, Darryl E.

DATING SEDIMENT BURIAL BY RADIOACTIVE DECAY OF COSMOGENIC AL-26 AND BE-10: TECHNIQUES AND UNCERTAINTIES

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Cosmogenic radionuclides such as Al-26 and Be-10 are produced in mineral grains primarily by nucleon spallation that occurs within 1-2 meters of the ground surface. Quartz sediment that is exposed near the surface and is subsequently buried contains Al-26 and Be-10 in a predictable ratio. Upon burial, the two radionuclides decay with different halflives, so their ratio can be used to date the burial event, with an effective range up to ~ 5 Ma.
Complications to the burial-dating technique include post-burial production by reactions with cosmic ray muons, which produce Al-26 and Be-10 at slow--but appreciable--rates at depths up to ~30 meters beneath the ground surface. I will discuss several applications and examples of the burial-dating technique, including sediments that are deeply buried in caves where muon reactions may be ignored, as well as sediments that are buried only 5-10 meters deep in river terrace deposits and alluvial fans, where muon reactions must be carefully accounted for. Post-burial production by muons can be accounted for in shallowly-buried sediments either by measuring a depth profile of Al-26 and Be-10, or in favorable circumstances by comparing Al-26 and Be-10 concentrations above and below a buried surface such as a paleosol or a strath. These examples will quantitatively demonstrate many of the uncertainties and limitations of the burial-dating techniques. Uncertainties are typically 100-300 ka, and are due primarily to uncertainties in production rates, decay constants, and measurements by accelerator mass spectrometry. I will also present comparisons between burial-dating and sediment paleomagnetism to quantitatively assess burial-dating accuracy.

1:50 PM Nichols, Kyle K.

THE BLACKHAWK KEEPS ITS SECRETS: LANDSLIDE DATING USING IN SITU 10-BE

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The Blackhawk, a large prehistoric landslide, is best known for its long runout distance (9.0 km) compared to its vertical drop (1.1 km) and the various mechanisms hypothesized to produce such a long runout . Just as elusive as the runout mechanism is the age of the landslide.
The age of the Blackhawk landslide has been estimated by radiocarbon at >17.4 +/- 0.6 ka (Stout, 1975). The date, measured on gastropod and pelecypod shells, picked from a calcareous mudstone bed in a pond on the landslide surface, has two potential problems; the pond from which the fossils were extracted is younger than the landslide and thus any age represents a minimum limit; the aquatic organisms may have incorporated 'dead' carbon from the pond water because the pond sits in carbonate rock.
We sampled gneiss boulders to date the landslide using cosmogenic 10-Be, three boulders (> 1m) from the top of a lateral ridge (BH-4, BH-5, and BH-6) and one boulder (>1.5 m) from the landslide-facing slope 3 meters below the ridge (BH-3). The 10-Be concentration of BH-3 is 3.48+/-0.15 x 10^5 atoms/g; concentrations in BH-4, 5, and 6 range from 6.4+/-0.45 x 10^4 to 9.3+/- 0.36 x 10^4 atoms/g. Exposure age (assuming a sea level, high latitude production rate of 6.03 a for BH-3 is 24.2 +/- 4.8 ka and exposure ages for BH-4, 5, and 6 average 5.7 +/- 1.1 ka.
Two scenarios may explain these disparate ages. Either, all samples have been exp since landsliding about 5.7 ka and BH-3 had exposure history prior to landsliding, or th slide is 24.2 ka and BH-4, 5, and 6 were covered by 3.5 to 5.5 m of sediment that has away exposing the boulders at a rate averaging 19 +/- 4 cm/ka. A combination of these members is also possible. Only further sampling and 10-Be analysis will better estimat of the Blackhawk landslide.

2:05 PM Perg, Lesley A.

10BE AND 26AL DATING OF THE SANTA CRUZ MARINE TERRACES, CALIFORNI YOUNG AGES

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The Santa Cruz coastline features a world-class flight of five marine terraces, which re history of large scale, rapid sea level oscillations along an uplifting coastline. As their a ages are unknown due to a lack of suitable material for U/Th dating, the terraces do no their potential to constrain uplift rates, examine rates of landscape evolution, and consi genic rates. The first terrace has been variously correlated with isotope stages 5a, 5c a estimated uplift rates range between 0.21-0.45 mm/yr.
On a stable surface the production of cosmogenic nuclides (CRNs) acts as a clock, yie age of the surface. The Santa Cruz terraces are capped by 1-4 m of regressive beach therefore both pre-depositional inheritance and post-depositional pedogenic effects, inc bioturbation, must be treated in any sampling and interpretation strategy. The expected centration profile should be homogenized within the bioturbated layer and exponentially below, asymptotically approaching the initial concentration of the capping beach sands. sites were selected on large flat areas showing no evidence of either colluviation or ero The measured CRN depth profiles in the first, second, fourth, and fifth terraces have m consistent 10Be and 26Al concentrations and display the correct relative age sequence each higher terrace exhibiting higher CRN concentrations. The top few tens of centime each profile display homogenization, presumably reflecting bioturbation.
Each profile is offset differently, reflecting variations in inherited CRN concentrations. Assuming stable surfaces, the best-fit model ages are: 47 ka for the first terrace, 87 ka second, 133 ka for the fourth and 230 ka for the fifth. These roughly correlate with the s highstand isotope stages 3 (56 ka), 5a (84 ka), 5e (125 ka) and 7 (212 ka). Modeling s several meters of erosion would be required to match previous age estimates for the te which is unlikely given their location. These age assignments imply a roughly steady up 1.15 mm/yr, two to four times greater than inferred from previous correlations.

2:20 PM Lifton, Nathaniel A.

A ROBUST SCALING MODEL FOR IN SITU COSMOGENIC NUCLIDE PRODUCTIO

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Realistic time-averaged estimates of the uncertainties inherent in scaling models for in s mogenic nuclide production rates are crucial for evaluating the significance of results in tions using these nuclides. These uncertainties arise from solar cycle modulation and p spectral variability of the cosmic-ray flux incident on the atmosphere, combined with the temporal and/or spatial resolution of cosmic-ray measurements. Furthermore, the use o ative measure (atmospheric absorption length) in published scaling models (e.g., Lal, 1 EPSL 104, p. 424, and Dunai, 2000, EPSL 176, p. 157) tends to mask primary variabilit data. These models thus tend to underestimate their respective time-averaged uncertain
I developed an alternative scaling model to address this issue using a more appropri meterization. I fit a surface directly to over 1200 published atmospheric neutron intensity urements. These data span portions of 4 solar cycles, with representative latitudinal and nal coverage. Fully propagated uncertainties in the model (1 sigma = approx. 8-12%) th reflect the true variability in the available data. Neutron intensity is parameterized in the m terms of effective vertical cutoff rigidity, Rc, and atmospheric depth, H. Essentially all stud atmospheric cosmic-ray intensity variation published since the early-1960s recognize tha vides a more robust means of scaling cosmic-ray intensity data than do conventional geo coordinates (Lal, 1991) or geomagnetic inclination (Dunai, 2000). Rc values also scale lin with geomagnetic field intensity, enabling more robust modeling of paleointensity fluctuati Time-averaged Rc values appropriate for cosmogenic applications were estimated from g graphic latitude using a geocentric axial dipole model which also incorporates time-avera nondipole field effects. I then compared the Lal (1991) and Dunai (2000) scaling factors w of this model between sea level and 6 km altitude, and from pole to pole, under the prese magnetic field. Fully propagated uncertainties indicate that the models are in general agr within 2 sigma. However, fractional differences between the scaling factors of Lal (1991) a Dunai (2000) and those of the new model can exceed 20%. Furthermore, varying the ma field intensity by +/- 20% yields fractional differences relative to the new model of up to 40 reflecting shortcomings of the published models' parameterizations.

2:35 PM Desilets, Darin

SCALING PRODUCTION RATES OF TERRESTRIAL COSMOGENIC NUCLIDES FOR ALTITUDE AND GEOMAGNETIC EFFECTS

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Methods of surface exposure dating using terrestrial cosmogenic nuclides require accura knowledge of the spatial variability of nuclide production rates. The hadron component of ondary cosmic-ray flux is responsible for a major fraction of terrestrial nuclide production. component is particularly sensitive to changes in both altitude and geomagnetic cutoff im on primary cosmic-rays. Production rates must therefore be scaled to account for any sp ations in these two factors.
Production rates have typically been scaled according to formulas derived by Lal (199 and Planetary Science Letters, 105: 424-439) from atmospheric measurements of slow-n intensity. More recently, Dunai (2000, Ibid 176:157-169) developed new scaling formulas on data from neutron monitors, cloud chambers and nuclear emulsions. We feel there are inadequacies in the available scaling models, a few of which we outline here: (1) They inc rate only cosmic-ray measurements taken prior to 1958. (2) Cosmic-ray data from latitude veys are ordered according to models which do not take into account the eccentricity of t magnetic dipole field. (3) They do not adequately address the effects of instrumental bias measurements of the neutron attenuation length.