PP51B-11 1125h

Oxygen Isotopes and Ring Widths in the Tropical Tree Species Polylepis tarapacana as Proxies of Past Precipitation in the Tropical Andes of South America.

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Dendrochronology is a powerful tool for the reconstruction of paleotemperatures in high latitudes and paleo-precipitation in the tropics. The measurement of ring widths and the analysis of carbon and oxygen isotopes within -cellulose have often been used to capture past climate variability. However, most workers have focused their studies in higher latitudes. Here we present preliminary data obtained from tree cores extracted from the alpine tropical tree species Polylepis tarapacana. This widely distributed Andean tree species exhibits robust annual growth rings.

We analyzed 18O values obtained from -cellulose and derived a ring width index from a tree growing on the slopes of Volcan Sajama. This location is significant as this forest is the highest in the world and because Sajama also has a permanent ice cap that has been previously analyzed for 18O at annual resolution for about one century and at much lower resolution for about 25,000 years (Thompson et al., 1998). It has previously been shown that ring widths of Polylepis at Sajama are well correlated with precipitation amount (Boninsegna, 2002). Here we show that our 40-year long cellulose isotopic time series is well correlated with the annually resolved ice core isotopic record, regionally-averaged instrumental records of precipitation, and the lake-level record of Lake Titicaca (located about 200 km to the north). The amplitude of variability for oxygen isotopes in precipitation and in cellulose is similar; the cellulose 18O averages about 44 per mil higher than that of the ice or precipitation. Most importantly, 18O of cellulose and precipitation amount are inversely correlated- more depleted 18O values in tree cellulose (and in the ice cores) occur in wetter years.

These results are promising for the future use of tropical tree cores as past climate proxies of precipitation; such studies are underway in our laboratory.

PP51B-12 1140h

Stable isotope analyses of palaeo-pollen records

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Pollen stratigraphy is one of the most widely used tools for studying climate and vegetation dynamics over global and multi-millennial scales. Since the isotopic compositions of photosynthates that are used to form the pollen structure reflect environmental conditions during the time of pollen formation, the stable carbon, oxygen and hydrogen isotopic compositions ($\delta^{13}C$, $\delta^{18}O$ and δD) of the pollen grains may reflect this environmental information.

Although there are many preliminary tests and methodological problems to overcome before we can fully utilise palaeo-pollen records, it is the general goal of our research to use pollen isotope records together with conventional palynological analyses to provide additional, independent spatial and temporal palaeo-environmental information and to provide new data on terrestrial ecosystem dynamics, including the timing of environmental changes, phase relationships of vegetation responses and regional and temporal variations in $\delta^{13}C$, $\Delta^{13}C$, $\delta^{18}O$ and δD. These isotopic records will facilitate in the modelling of palaeo-environments. By separating and analysing different pollen species, including C_3 and C_4, we also aim to assess species-specific climatic responses.

We present results describing some recent investigations concerning the nature of the isotopic signal contained within pollen, the methodological developments we have made to measure the pollen isotopic composition and the future challenges that must be overcome before this potentially powerful quantitative terrestrial palaeo-archive can be fully and correctly utilised.

PP52A MCC: Hall D Friday 1330h

Interpreting Climate Change From Isotopic Records of Precipitation II Posters *(joint with A, H, OS, GC)*

Presiding: **J L Teranes,** Scripps Institution of Oceanography**; W Anderson,** Florida International University

PP52A-0306 1330h POSTER

Canadian Network for Isotopes in Precipitation (CNIP)and Isotope Climatology and Hydroclimatology in Canada

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The distribution of stable isotopes in precipitation provides fundamental information about the partitioning of the global atmospheric water budget, and hence about key aspects of Earth's climate, that cannot be discerned using other means. Although continuing demand exists for monitoring of isotopes in precipitation to define isotopic input functions for local hydrologic studies or for calibration of isotopic indicators of paleoclimate, based on longterm averages and climatological norms, awareness is also growing of the significant value of the monthly snapshots of the precipitation isotope field provided by the IAEA/WMO Global Network for Isotopes in Precipitation and its affiliated national networks as benchmark maps of the ongoing and dynamic evolution of the global water cycle.

An initiative within the Canadian Network for Isotopes in Precipitation program includes development of a spatial and temporal database incorporating Canadian data to create a gridded isotope overlay compatible with gridded pressure and flux field data from the NCAR/CDAS Re-analysis Project. This database includes interpolated fields of our current best approximations of climatological isotopic means in addition to the original monthly data for the period 1997-2000. Studies are underway to test the sensitivity of the isotope-climate signal in precipitation to changes in these parameters utilizing perturbations in local climate arising from the El Nino/Southern Oscillation (ENSO). Intriguing results have been obtained from preliminary studies incorporating pressure and flux field data for the 1997-98 El Nino with CNIP isotope overlays. The strongest climate anomalies were found during the winter following the 1997 El Nino event, consistent with the expected strengthening of the Pacific North American pattern during this period. Comparisons of the isotopic fields with climate fields illustrate the complexity and dynamic nature of isotope climate not evident in time-series of data from individual stations.

PP52A-0307 1330h POSTER

Atmospheric Circulation And The Oxygen Isotopic Composition Of Meteoric Precipitation Over The Eastern United States

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Delta18O information captured in ice cores, carbonate deposits, and plant cellulose are strongly dependent on the isotopic composition of meteoric precipitation, which is controlled by fractionation processes associated with the condensation and evaporation of water vapor. These processes are influenced by several related factors, including air temperature and water vapor source region. Although delta18O information has been used primarily as a surrogate for air temperature, the impact of water vapor source region on isotopic variability suggests that these data can offer important insights into variations in atmospheric circulation. The objective of this study is to develop an understanding of the relationship between atmospheric circulation and the oxygen isotopic composition of meteoric precipitation, apart from that caused by air temperature variations. To accomplish this goal, we examine the statistical relationships between historic records of precipitation delta18O and atmospheric circulation for two sites in Eastern North America.

Historic precipitation delta18O data were obtained from the International Atomic Energy Agency (IAEA) Global Network for Isotopes in Precipitation (GNIP) record. The GNIP record for Eastern North America consists of 12 stations with variable record lengths. Chicago, Illinois and Ottawa, Ontario possess the longest records (18 and 24 years) and represent the focus for this work. Atmospheric circulation indices were derived from 500-hPa geopotential height data contained in the National Center for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) Reanalysis Project. The 500-hPa data were used to calculate the position of the polar front jet stream over North America for January, April, July, and October for those years in which GNIP data were available. These months were chosen as representatives of each season. A rotated principal components analysis was used to develop circulation indices from the jet stream position data. These indices represent the primary modes of polar frontal circulation that occur over North America.

When compared statistically to the isotopic records, the 500-hPa circulation indices explained a larger proportion of the delta18O variability than air temperature alone. The circulation-delta18O relationships are strongest for Chicago in winter and reflect variations in the amplitude the jet stream. During winters in which the jet stream is highly amplified and features deep troughing over the eastern United States, precipitation delta18O is significantly lower. Similar, but weaker relationships are found in Ottawa and in other months. Despite the limited amount of historic oxygen isotope data in the GNIP record, these results do provide insight into the ways in which North American circulation influences the delta18O of meteoric precipitation. These relationships can be especially useful as a method of reconstructing atmospheric circulation from delta18O contained in pre-historic environmental records.

PP52A-0308 1330h POSTER

What Climate Information is Recorded in Isotopic Content of Andean Precipitation, South America ?

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Several andean ice cores studies have been carried out for the last years in Bolivia (Sajama, Illimani), in Peru (Huscaran) and in Equator (Chimborazo). Although the long term trend of isotopic histories clearly reflect well known periods (deglaciation, period associated to the Younger Dryas cooling in the North Atlantic sector, Holocene optimum), the interpretation of the high resolution data over the last centuries is more difficult because of the complexity of the hydrological cycle in the tropics and subtropics (cloud convection, recycling over Amazonia, partial evaporation of droplets at the based of the cloud). To better understand the seasonal isotopic signal recorded in those ice cores, we need to calibrate the isotope content of precipitation regarding local and/or regional and/or source meteorological parameters, factors controlling precipitation isotopic composition. Indeed, water stable isotopes offer a unique integrated information about an air mass history from the evaporation at the ocean surface to the precipitation. In this context, a network sampling either each event of precipitation or monthly precipitation has been set up for more than 3 years in Bolivia and in Equator and for less than one year in the Northern Peru. We present here first analyses of both deuterium and oxygene 18, leading to deuterium excess variations, from Bolivia and Peru. Daily data show an organized signal but nearly none correlation with a peculiar local meteorological parameters (temperature, relative humidity or amount of precipitation). However, monthly data clearly exhibit a phase shift of about one month with the amount of precipitation, the later minimum leading the isotope maximum. Deuterium excess variations are approached in terms of recycling strength. Although suitable models for this region are not available yet, we further examine our data with NCEP reanalyses and simulations with ECHAM model. Both show an interesting correlation of isotopes with regional (Amazonia) precipitation. This might

indicate a regional control of andean precipitation instead of a local control. The poorly representation of deuterium excess in modelling studies prevents us from further exploring its variations right now.

PP52A-0309 1330h POSTER

Interpolated δ^{18}O and δD Values of Modern Rainwater and the Confidence of These Predictions: Towards an Integrated Model for the Interpretation of δ^{18}O and δD Records

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The oxygen and hydrogen stable isotope compositions of meteoric waters and authigenic or biologic minerals from non-marine deposits can provide important information about hydrologic processes and climate change. These applications commonly require estimates of the isotopic compositions of waters entering the system under study. While direct monitoring of hydrologic sources is a viable approach in some cases, it is not possible in others. Also, investigations into climatic and hydrologic changes occurring over timescales of 10^2 years or greater might be biased if data from short-term monitoring projects are used to represent the modern system. As a first step towards an integrated, model-based approach to interpreting oxygen and hydrogen isotope records, we present detailed maps of the spatial distribution of the mean annual δ^{18}O and δD values of rainwater interpolated from a global data set using the most accurate model currently available. In addition, we provide maps of the confidence intervals for these predictions. The model predicts the stable oxygen and hydrogen isotope composition of rainwater accurately, with average errors of $<$ 1.2 and 9.2$^o/_{oo}$, respectively. Our maps average $\sim$ 40 years of data, providing a representation of the modern system that is well suited for comparison with many paleoclimate proxy records and application to many hydrological questions. Integration of this model with models for precipitation/evaporation, runoff, infiltration, and mineral precipitation will provide a rigorous and quantitative foundation for the interpretation of δ^{18}O and δD records from a variety of terrestrial sources and allow estimation of associated uncertainties.

PP52A-0310 1330h POSTER

Comparison of River Water and Precipitation δ^{18}O Across the 48 Contiguous United States

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A variety of proxies for ancient meteoric precipitation δ^{18}O have been employed to reconstruct paleoclimates including compositions of glacial ice, speleothems, pedogenic carbonate and hematite, authigenic clay minerals, lacustrine carbonate, meteoric cements, and biogenic hardparts such as teeth, otoliths, and bivalve shells. Because many of these techniques rely upon the assumption that the isotopic composition of the surface or groundwater is analogous to that of precipitation in the same locality, we have undertaken a quantitative comparison of the oxygen isotope (δ^{18}O) composition of modern river water and precipitation across the entire U. S. using data from the USGS gauging stations, U. S. Network for Isotopes in Precipitation, and data compiled from the literature.

We have generated maps of modern mean annual δ^{18}O for both precipitation and river water across the 48 contiguous United States using latitude and elevation as our primary predictors of stable isotope composition while also incorporating regional and local deviations from this simple model based on available isotopic data. Differences between precipitation and river water compositions were calculated at each grid point (spaced at 30 arc seconds) to generate a final map that displays regions where river water δ^{18}O is similar to, or significantly offset from local precipitation δ^{18}O. Additional maps depicting seasonal and extreme values for river water and precipitation were also constructed.

Across most of the Great Plains, river water δ^{18}O is significantly more positive than precipitation, while throughout much of the western United States river water is depleted in ^{18}O compared to local precipitation. One of the most salient features that emerged from this comparison is the "catchment effect" for the river water. Because river water samples are largely derived from precipitation that occurs upstream of the sample localities (*i.e.*, at higher elevations), river water δ^{18}O values are lower than local precipitation δ^{18}O values, particularly in basins with high elevation gradients. Moreover, amplitudes of seasonal variation in isotopic compositions are greatly dampened in river water relative to precipitation.

PP52A-0311 1330h POSTER

The Deuterium Excess in Precipitation and Atmospheric Moisture in the Southern Great Plains Region of USA

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Systematic study of variations in the isotopic ratios of oxygen and hydrogen in various components of the water cycle is helpful for understanding local and regional hydro-climatology. The relationship between the isotopic ratios of oxygen and hydrogen in precipitation, defined as the Meteoric Water Line (MWL) yields valuable information about the climatic factors and secondary moisture sources which influence the precipitation process, when compared with global MWL(δD = 8*δ^{18}O + 10). It is estimated that a significant portion of precipitation on land is a result of evapo-transpired moisture that is recycled in the atmosphere. In order to understand the response of regional water cycles to climatic variations, it is important to quantify the influence of locally derived moisture on precipitation. The Deuterium Excess (defined as: d = δD - 8*δ^{18}O) in precipitation is a valuable tool for estimating the contribution of such secondary moisture sources to precipitation.

As part of the DOE Water Cycle Pilot Study to improve predictability in part by integrating stable isotope variations in to climatological models, atmospheric vapor samples were collected in the southern Great Plains region. Vapor samples were collected at the surface and between 900 and 5000 meters(msl) and were analyzed for their δD and δ^{18}O values. The δD and δ^{18}O of the vapor samples showed a progressive depletion with increasing altitude. The samples collected below the Atmospheric Boundary Layer (ABL) showed a remarkable increase in the d-excess (19$^o/_{oo}$) compared to the sample above the ABL (4$^o/_{oo}$). Precipitation samples collected in 1999 from the National Atmospheric Deposition Program (NADP) stations in Texas and Oklahoma were also analyzed for their stable isotope values. The precipitation in the inland station of Oklahoma is characterized by higher d-excess than that of the coastal Texas station. Such higher d-excess is shown to result from an admixture of locally evapotranspired moisture with the moisture from the Gulf of Mexico, the predominant source of precipitation in the Great Plains region.

PP52A-0312 1330h POSTER

Synoptic Investigations of Precipitation Isotopic Composition in Central North America

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Winnipeg, Canada, is influenced by three major air mass streams in addition to experiencing one of the largest seasonal temperature variations in North America. These climate characteristics make Winnipeg an ideal site to further quantify synoptic relations to precipitation isotopic composition.

A pilot study comparing atmospheric circulation and air mass characteristics (based upon Winnipeg's hourly and daily surface observations of temperature, humidity, wind and cloud cover) revealed that the seasonal variation in precipitation isotopic composition for the years 1992 and 1993 was subdued compared to temperature-predicted values. Summer isotopic compositions are depleted for both these years compared to those predicted by the average temperature during the precipitation event suggesting that the source of the summer air masses were remote to central North America. Winter compositions are similar to temperature predicted values.

To further the initial success of this pilot study the Manitoba Network for Isotopes in Precipitation (MNIP) was established in partnership with the Science Council Manitoba to amalgamate a network of schools to collect precipitation for oxygen and hydrogen isotopic analysis. This broad and dense network of school-based precipitation collection sites will provide isotope information at an unprecedented spatial resolution. The information generated by this network has great potential to help climate researchers produce better estimates of climate variability. It is also hoped that this program will seed the growth of similar programs in Saskatchewan and Alberta, thereby providing the Canadian Network for Isotopes in Precipitation (CNIP), and ultimately its global partner (GNIP), with detailed accounts of water isotope-climate information that can aid in the implementation of water isotopes as tracers in models used to investigate global climate dynamics and climate change.

PP52A-0313 1330h POSTER

Functions Controlling Hydrogen and Oxygen Stable Isotopes of Precipitation in the Continental United States: Summarized Using GIS

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Since its inception in 1978, the National Atmospheric Deposition Program (NADP) has collected and archived weekly precipitation samples from what now amounts to over 200 sites. We have seized this opportunity to analyze archived water samples, from 65 sites, for both hydrogen and oxygen stable isotopes, spanning 1989 to present. This data is used to determine the degree to which certain factors contribute to fractionation of precipitation stable isotopes. The factors of interest are seasonality of precipitation, temperature, distance from moisture source, altitude, and precipitation amount. Geographic Information Systems (GIS) has been used as an analytical tool to determine the spatial and temporal relationships between the stable isotopic composition of water and such parameters. The results from such a grand data set brings higher resolution to conclusions drawn from previous studies, and the use of GIS culminates in isotopic spatial models of the continental United States, calibrated by goespatial and temporal parameters.

PP52A-0314 1330h POSTER

Interpreting Oxygen and Hydrogen Isotope Ratios in Precipitation Using a Coupled GCM

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While very important, particularly for paleoclimatology, interpreting the oxygen and hydrogen isotope ratios in precipitation and records of precipitation is not straightforward. The source region and the convoluted hydrometeorological details of the trip to the final destination determine the final isotopic ratios in the precipitation. Without some knowledge of these, little can be gleaned with any certainty from the isotopic ratios in the precipitation and its records. Perhaps the most effective (albeit far from perfect) way to do this interpretation is through the use of General Circulation Models (GCMs), which include the relevant hydrometeorological processes. Further, since the source region is a major influence and is usually the ocean, which is variable on many time scales, coupled ocean-atmosphere GCMs should be used rather than just atmosphere GCMs. For these reasons, oxygen 18 and deuterium were added as tracers in the full water cycle (e.g., changes due to cloud, sea ice, ocean, and land surface processes, with isotopic fractionation at phase changes) of a parallelized coupled GCM of 5 x 4 degree resolution and a multi-decadal present-day control run performed. The results are discussed and paleo runs are outlined.

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PP52A-0315 1330h POSTER

Teasing Cellulose Isotopic Signals Apart by Chemical Methods

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The δ^{18}O and δD values of precipitation water correlates with changes in atmospheric circulation patterns and temperature. This has been the basis of many attempts to use fossil tree ring cellulose as a proxy for paleoclimate. Ideally by measuring δ^{18}O and δD values of tree ring cellulose one would infer isotopic composition of water available for plant uptake, which presumably is the least isotopically altered from precipitation. Subsequently, paleo-temperatures or atmospheric circulation patterns at the time of cellulose formation could then be inferred. However, this goal is confounded by isotopic exchange processes occurring in the leaf. Our current understanding of the physiological/biochemical mechanisms operating during the labeling of carbohydrates by water during tree ring cellulose synthesis indicates that the isotopic composition of tree ring cellulose is a mixture of isotopic signals coming from source (CA 35 to 45%) and leaf (CA 55 to 65%) water. The isotopic composition of the latter component is radically modified from that of the original source water by factors such as relative humidity and leaf properties. Here we present a chemical method of derivatizing cellulose to tease these two signals apart. We analyze the isotopic composition of cellulose and its derivative and calculate the δ^{18}O value of the oxygen attached to the second carbon of the glucose moieties in cellulose (^{2}C-OH). A one to one relationship between δ^{18}O values of this oxygen and that of water available for cellulose synthesis in seeds germinated in the presence of water having different δ^{18}O values was observed. Indicating that ^{2}C-OH undergoes complete exchange with water during the synthesis of cellulose from sucrose. This technique can potentially be an analytical tool in paleo-climatic and ecological studies, once the analytical techniques are refined so as to increase precision.

PP52A-0316 1330h INVITED POSTER

A Proposed Link Between Atmospheric Circulation and Stable Oxygen Isotope Values From Tree-Ring Cellulose, Fayetteville Green Lake, New York.

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Very few paleoclimate proxy records exist which highlight the relationship between atmospheric circulation patterns and stable oxygen isotopes of precipitation for the Northeastern United States. Here, we present the initial stable oxygen isotope results (n=55) from cellulose extracted from a 140-yr tree-ring record (Yellow-Poplar; Liriodendron tulipifera). Located within the drainage basin of Fayetteville Green Lake (Fayetteville, NY), this specimen was felled during a wind-storm on Labor Day 1998. A whole-diameter tree-slab was removed for tree-ring counts and cellulose extraction. Comparison of the tree-ring cellulose stable oxygen isotope values to spring average temperature and mean latitude of the spring season polar vortex (measured at the 500 hPa geopotential height between 85W and 60W longitude) reveal intriguing relationships. d18O cellulose values are correlated to both the latitude of the spring season vortex (r=0.61; alpha=0.1) and the spring season average temperature (r=0.47; alpha=0.1). The correlation between spring season latitude and the average spring season temperature is also statistically significant (r=0.74; alpha=0.1). From these data, we propose an atmospheric circulation-water stress hypothesis to explain the d18O cellulose values between 1943 and 1998 AD. A contracted (i.e., higher latitudes) spring season vortex produces warmer average spring season temperatures by reducing the frequency of excursions of cold air masses into the middle latitudes. As the temperature of the spring season increases, the rate of evapotranspiration similarly increases leading to the preferential removal of 16O from the tree leaf via increased water stress. As a result, the cellulose subsequently produced has higher average oxygen isotope values. Comparison of the cellulose d18O data to calcite d18O values obtained from nearby Fayetteville Green Lake (about 100m NE from the tree site) for overlapping intervals show intriguing similarities and dissimilarities suggesting that the source water and dominance of source water for each climate proxy (i.e., cellulose and calcite) changes over time. Use of cellulose and calcite d18O values from adjacent sites may provide important insight to the interpretation of their respective climate signals.

PP52A-0317 1330h POSTER

Oxygen isotope records from semi-tropical trees as high-resolution indicators of recent climate change, from South Florida to Brazil

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The development of new proxy climate records and approaches that allow for investigation and comparison of widespread regions, will enhance the global understanding of past climate change through better correlations of significant events among different locations. Trees with a global distribution ranging from the tropics to the subarctic are an ideal medium from which to develop high-resolution isotopic records equivalent to those from ice cores and varved lake sequences. Here we present the results of several projects which focus on the oxygen isotopic analysis of tree rings from semi-tropical trees. Typically trees in tropical hardwood hammocks lack the rings necessary for proper dendrochronology. However, in semi-tropical ecosystems where strong seasonality between wet and dry seasons occur, certain species do form annual rings. The species we used are *Pinus elliottii* from the Florida Keys, and *Araucaria angustifolia* from southeastern Brazil. Each species has distinct rings, although the chronologies are complicated by the presence of false rings. The analyses completed on the chronologies presented indicate it is possible to reconstruct the oxygen isotopic composition of the precipitation these trees where using over the last century.

PP52A-0318 1330h POSTER

Has the relationship between the oxygen isotopic composition of precipitation and air temperature remained constant over the last century? An example from central Europe

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Isotope records from lake sediments and tree rings provide important archives from which long, high-resolution proxy records of continental climatic change may be reconstructed. In particular, annually-laminated records such as tree rings and varved sediments provide the advantage of yearly resolution, enabling the direct comparison of sub-decadal changes between both archives. Here, we compare oxygen isotope calibrations of two 20th century precipitation archives secured from the same catchment area: (1) a varved lacustrine sequence from Baldeggersee, a small eutrophic lake located in Central Switzerland and (2) a tree-ring cellulose core from a tree located within 1 km of the lake. Oxygen isotopic values of lacustrine bio-induced calcite represent an integrated record of the isotopic composition of precipitation feeding the lake, modulated by evaporative effects and the lake?s residence time. Trees record the isotopic composition of precipitation utilized during photosynthesis, occurring from May to September in our study area.

Oxygen isotopes in precipitation typically show a positive correlation with air temperature and an inverse relationship with the amount of precipitation. The lake oxygen isotope record shows a positive correlation with air temperature from 1880 to 1960 of $0.42^{o}/_{oo}/\ ^{\circ}$C; but, after 1960 this isotope trend is reversed. Over the entire study period (1913 to 1995), the tree record displays a correlation with the average air temperature data of $0.79^{o}/_{oo}/^{\circ}$C during the growth season from May through September, but the correlation decreases to $0.42^{o}/_{oo}/^{\circ}$C in the interval between 1971 and 1995. Interestingly, from 1940 to the late 1980s, both the lake and the tree isotope records display to a first-order depletion cycle (approx. $2^{o}/_{oo}$decrease). This depletion trend is not consistent with the global mean air-temperature increase, which is locally represented by an over 1°C increase in our study area. This result, together with the two different observed correlations for the tree rings over different time periods, indicate that the relationship between the oxygen isotopic composition of precipitation and air temperature has not remained constant with time and suggests that other factors, such as changing atmospheric circulation patterns, must be considered when interpreting these isotope proxy records of climate change.

PP52A-0319 1330h POSTER

1000 Years of North American Climate Variability as Inferred from Lake Carbonate Stable Isotope Records

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This study presents stable isotope data from annually-laminated (varved), carbonate-containing sediment sequences from three sites in the upper North American mid-continent region (MI, USA and Ontario, CA). Approximately 60-80 cms of undisturbed sediment were obtained by freeze-core methods at each site. Accurate age chronologies, based on varve counts and high-resolution ^{14}C dates on terrestrial macrofossils, confirm the annual nature of the laminations and verify core bottom dates of between 900-1000 AD.

Paleoclimate reconstructions from lake carbonate isotope records require understanding of how the isotopic composition of precipitation varies in response to climate change in any given region, how isotopic composition of precipitation is modified en route to the surface water reservoir, and how the water isotope signal is preserved in the lake carbonate record. Lake water oxygen and deuterium isotopic compositions from the three sites primarily reflect the isotopic composition of regional precipitation, with modifications by local hydrologic and evaporative processes. In this sense, examination of three different lake sites with distinct local evaporative regions is critical for assessing reproducibility and validation of a regional climate signal. Isotope data from sedimentary carbonate in the uppermost layers confirm that carbonate accurately reflects the isotopic composition of the surface lake water, after accounting for the isotopic fractionation associated with ambient water temperature. Together, this material provides an ideal proxy for extending the time series of isotopes in precipitation to calibrate to the instrumental database and to compare with existing reconstructions of climate change over North America during the last millennium.

Initial comparisons between down-core δ^{18}O values and instrumental data support oxygen isotope compositions as a quantitative proxy for regional air temperature. The positive correlation between lake carbonate isotope record and temperature is especially pronounced in winter months, when the spatial scale of the Pacific/North America pattern is most expansive, suggesting that lake isotope records provide valuable monitors of broad-scale climate variability. Further analyses of these high-resolution climate records will assess regional expressions of climate events of the last millennium, including the Medieval Warm Period, the Little Ice Age and the late 20th century climate warming.

PP52A-0320 1330h POSTER

Quantitative Assessment of Present and Past Hydrological Status of Spruce Island Lake, Peace-Athabasca Delta, Canada, Using Water Isotope Tracers

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Concern over drying of the Peace-Athabasca Delta (PAD), Canada, the worlds largest inland freshwater delta, has been heightened by construction of the WAC Bennett Dam at the headwaters of the Peace River in 1968 and the absence of a major ice-jam flood from the mid-1970s to the mid-1990s. Ice-jam floods are critical for recharging the hundreds of perched basins in the PAD, which provide extensive wildlife habitat. To improve our understanding of the present and past hydrology of the PAD, we are conducting extensive multidisciplinary research with the aim of distinguishing the impacts of both natural and anthropogenic factors on this ecosystem, including climate variability and flow regulation of the Peace River. Water isotope tracers, in particular, have provided an exceptionally sensitive tool for developing a quantitative framework of both modern and past hydrological conditions.

Results from stable isotope analyses of lake water collected over three years from Spruce Island Lake, a shallow (1 m) closed-drainage lake in the Peace Delta sector, display a predictable pattern of isotopic depletion in the spring due to snowmelt dilution followed by progressive evaporative isotopic enrichment over the ice-free season. The summer of 2001 was particularly dry as reflected by more than 4 per mil enrichment in O-18. Preliminary calculations indicate that this reflects a shift from approximate balance between evaporation and input ("terminal lake" status) to a strongly negative transient water balance in which the evaporative flux was substantially greater than input from precipitation and runoff.

High-resolution analyses of the oxygen isotope composition of aquatic cellulose extracted from a sediment core from Spruce Island Lake, a proxy for lake water oxygen isotope composition, also reveal substantial paleohydrological variability over the past 300 years. Constraints on decadal variations in temperature, relative humidity and the oxygen isotope composition of precipitation, based on tree-ring cellulose isotope data upstream from the PAD, help to support a quantitative water balance reconstruction for Spruce Island Lake. Results indicate that strongly negative water balances ($I << E$) characterized most of the 1700s, whereas positive steady-state water balance ($I > E$) persisted during 1785-1935. Since 1935 the lake has behaved, on average, like a closed-basin terminal lake, with inferred E/I ratio around 1. The isotope-based water balance reconstruction for Spruce Island Lake, coupled with diatom analyses on the same core and multiproxy paleohydrological records at other sites in the Peace sector of the PAD, suggests that climate plays a dominant role in driving local hydrological variability at subdecadal and longer time scales. Notably, sub-decadal averaged water balance conditions at Spruce Island Lake during the post-regulation period are within the range of natural variability observed over the past 300 years.

PP52A-0321 1330h POSTER

A Reconstruction of Humidity Changes for the Last 8000 Years, Yukon Territory, Canada

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Oxygen isotope data from authigenic carbonate in the sediments from two geographically proximal lakes are used to calculate changes in humidity. Jellybean Lake (60.351 °N, 134.805 °W) is hydrologically open with modern lake water $\delta^{18}O$ similar to rivers, spring water and precipitation (-21 per mil) in the region. Sediment-core carbonate values range from 19 to 21 per mil. Marcella Lake (60.074 °N, 133.898 °W) is hydrologically closed, such that most all of the outflow is via evaporation. Modern lake water in Marcella is -8 per mil and sediment-core carbonate values range from -8.5 to -12 per mil. Because Marcella Lake has been hydrologically closed throughout the Holocene, sediment-core $\delta^{18}O$ values are primarily controlled by changes in regional humidity, which will govern evaporation rates. However, changes in the $\delta^{18}O$ values of input waters, either because of changes in ambient temperature or moisture source regions, or both, may also be responsible. The latter factors can be accounted for by the changes in the $\delta^{18}O$ of hydrologically open Jellybean Lake because the lake water is isotopically equivalent to meteoric precipitation. The 1-cm sampling interval used is equivalent to 20 years time. Chronologies for both lakes are constrained by ^{210}Pb, the depth of the White River Ash and radiocarbon ages from terrestrial macrofossils.

We calculate the isotopic enrichment in Marcella Lake due to evaporation by correcting the $\delta 18O$ data with Jellybean Lake $\delta^{18}O$ data. Changes in humidity were determined using a model of a terminal lake at hydrological and isotopic steady state. The $\delta^{18}O$ of the uppermost sediments generate humidity values between 63 and 65%, which are consistent with the average humidity in Teslin, YT of 64.9%. During the last 2000 years, high values of 70% between 2000 and 1200 cal yr B.P., are followed by a dry cycle between 1200 and 800 cal yr B.P. Intermediate values between 65 and 68% occurred between 800 and 300 cal yr B.P. At 290 cal yr B.P. (1660 AD), a very large and rapid shift from 70 to 59% occurs over a 20 year period after which values rise steadily to the present day. These quantitative estimates are the first of their kind for this semi-arid region of the Arctic where changes in aridity may be the predominant manifestation of climate change during the Holocene and into the future.

URL: http://www.geo.umass.edu/gradstud/land

PP52A-0322 1330h POSTER

The Paleoclimate Of The Dead Sea Basin From The Last Glacial Maximum To The Holocene

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The purpose of this study was to determine the late glacial paleoclimate of the Southern Levant. A study of 13C and 18O in carbonates (aragonite) was undertaken from a Lisan Core 3, a laminated core, collected from the Lisan Peninsula in the Dead Sea. Accelerator Mass Spectrometer (AMS) ages demonstrated that the core spanned the period from the Last Glacial Maximum (LGM) to the Holocene (20-12 thousand years ago (kya)). Results derived from carbon and oxygen isotopes provide insight into the paleoclimate of the Southern Levant. The period from 20-14.6 kya was dry and cool, with little organic matter being washed into the Dead Sea Basin. This interpretation is based on higher isotopic values (13C values as high as 1.57) than are found in the modern Jordan River, which has 13C values of V7.2. During the interval from 14.2-12.5 kya, values for 13C and 18O were much more dilute, with 13C values as low as V14. This dilution demonstrates increased precipitation and/or flooding events that washed organic matter into the basin. The results of this study agree with other studies based on paleolake levels, pollen levels and paleoclimate studies from the Dead Sea Basin.

PP52A-0323 1330h POSTER

New Proxy for Recent Hurricane Events Using Stalagmite Stable Isotopes

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Using recently developed micro-sampling techniques for stable isotope analyses, we obtained monthly to weekly temporal resolution in a fast growing stalagmite from Belize that recorded the last 3 decades of carbonate deposition. The stable oxygen isotope record (O-18 values) varies at interannual to sub-seasonal scales. The largest variations in O-18 values are interannual (corresponding to El Nino events) and annual (corresponding to the strong wet-dry seasonality of the region). Smaller amplitude O-18 variations related to short-term weather fluctuations are also apparent.

Brief, low excursions in O-18 values can be identified with hurricane events that impacted Belize in recent decades. This dataset demonstrates that at least some stalagmites can record measurable, low stable oxygen isotope excursions from individual hurricane rainfall events. The proxy is sensitive to storm intensity and distance of storm track to the cave site. This paleotempestology proxy allows estimates of individual storm rainfall amounts and recurrence interval. Pre-historic hurricane events should be detectable using this technique; however, cave sites and individual stalagmites must be selected carefully to recover samples with measurable hurricane records.

PP52A-0324 1330h POSTER

Speleothem Records of Glacial-Interglacial Transitions in the Sierra Nevada, California

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The degree of synchronicity between regional and global climate change in western North America remains an open question. For example, periods of desiccation in Basin and Range pluvial lakes have been linked to climate oscillations in the North Atlantic during deglaciation, while temperature records from the western Basin and Range and California coast suggest that warming in western North America preceded global deglaciation. In response, we have acquired four speleothems from three caves in the foothills of the Sierra Nevada that date back 160 ka. Preliminary stable isotope (δ^{18}O and δ^{13}C) and TIMS U-series investigation of the specimens show that the speleothem isotopic compositions vary from glacial to interglacial in a systematic fashion. Specifically, δ^{18}O values are low ($-10^{o}/_{oo}$) during the glacial stages, and high ($-6^{o}/_{oo}$) during the interglacial stages. We interpret the large shift in δ^{18}O values from glacial to interglacial conditions as due to a combination of increased air temperature and reduced precipitation amounts during interglacials, a combination ultimately affecting the isotopic composition of precipitation entering the cave as dripwater. In addition, speleothem growth rates slow during interglacial periods, further evidence for decreasing precipitation amounts from glacial to interglacial. This trend is broadly consistent with pluvial lake and other climate records from the western Basin and Range. Because similar isotope values and growth trends are preserved in speleothems separated by 150 km distance and 600 m elevation, we are confident that the signal reflects regional climate change. These high-resolution speleothem records should ultimately aid in resolving the timing and magnitude of climate events in western North America relative to those in the North Atlantic and elsewhere.

PP52A-0325 1330h POSTER

Seasonal Deuterium Excess in a Tien Shan Ice Core: Influence of Moisture Transport and Recycling in Central Asia

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Stable water isotope ($\delta^{18}O$, δD) data from a high elevation (5100 masl) ice core recovered from the Tien Shan Mountains, Kyrgyzstan, display a seasonal cycle in deuterium excess ($d = \delta D - 8*\delta^{18}O$) related to changes in the regional hydrologic cycle during 1994-2000. While there is a strong correlation ($r^2 = 0.98$) between $\delta^{18}O$ and δD in the ice core samples, the regression slope (6.9) and mean d value (23.0) are significantly different than the global meteoric water line slope of 8 and global d value of 10. The resulting time-series ice core d profile contains distinct winter maxima and summer minima, with a yearly d amplitude of 15-20 $^{o}/_{oo}$. Local-scale processes (i.e., sublimation, partial summer melting, snow formation temperature) that may affect d values preserved in the ice core are not consistent with the observed seasonal variability. Rather, we suggest that regional-scale hydrological conditions, including seasonal changes in moisture source, transport, and recycling in the Caspian/Aral Sea region, are responsible for the observed d variability. Examination of data from the Global Network of Isotopes in Precipitation (GNIP) indicates similar seasonal changes in southwestern Central Asian (Afghanistan and Tajikistan), likely related to moisture supply from the Mediterranean Sea during summer. The two years with the highest d values in the ice core record are 1997 and 1998, suggesting a possible link to ENSO ocean/atmosphere variability. The isotope data presented here provide a basis for interpreting centennial-scale ice core d records currently being developed from the region, and highlight the complexity of time-series isotope records from mid-latitude ice cores.

PP52A-0326 1330h POSTER

A Multi-Proxy, Paleomonsoon Record Based on Speleothems From Central China

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The oxygen isotopic composition of cave calcite deposits (speleothems) formed through equilibrium processes is a function of cave temperature and drip-water composition, which is closely related to precipitation. Oxygen isotopic variations in speleothems from mid-to-high latitudes have been widely used as isotopic paleothermometers, because of the strong relationship between $\delta^{18}O$ of precipitation and surface temperature in these regions. Interpretation of speleothem records from lower latitudes or from regions with complex atmospheric circulation patterns, such as the Asian monsoon region, is much less straightforward. In regions affected by the Asian monsoon, past variations in $\delta^{18}O$ and δD of precipitation have been attributed to variations in monsoon intensity, storm tracks, and/or variations in temperature. We have investigated the strength of the transfer functions, $d\delta^{18}O_p/dT$ and $d\delta^{18}O_p//dP$, in China using multiple regression analysis of data from the Global Network for Isotopes in Precipitation (GNIP). We determined that in areas which experience a strong summer monsoon, the amount effect is dominant, i.e. $\delta^{18}O$ is lowest in the summer. In areas that are less influenced by the summer monsoon, temperature is the dominant control on $\delta^{18}O$ and, hence $\delta^{18}O$ is lowest in the winter. The slopes of these relationships, however, vary spatially and temporally as monsoon intensity changes. Therefore, use of oxygen isotopic variations in speleothems from China as a quantitative paleotemperature or paleoprecipitation proxy may not be valid.

We present oxygen isotopic records from 3 stalagmites collected from Wanxiang Cave, Gansu Province, China (33.31° N, 105.00° E.) The speleothems are well dated by TIMS U-series analyses. Favorable ($^{230}Th/^{232}Th$) of 350-3000 result in only very minor detritus corrections. Ages preserve stratigraphic order and range from approximately 20-313 ka. Several depositional hiatuses throughout this period correspond to global stadial periods when speleothem growth stopped in Wanxiang Cave, most likely due to decreased precipitation. Our isotopic calibration shows that modern speleothem calcite forms in equilibrium and that there is no significant kinetic fractionation in Wanxiang Cave. At this site, oxygen isotopes in precipitation, and hence in the speleothems, are inversely related to temperature. Significant shifts are seen throughout the records, reflecting high and low amplitude changes in monsoon intensity, some of which have been documented in other paleorecords. Due to the complicated systematics of stable isotopes in precipitation here, however, we use uranium concentration and isotopic data as additional evidence. Initial ($^{234}U/^{238}U$) and U concentrations are positively correlated with $\delta^{18}O$ in the speleothems. This lends support to the use of $\delta^{18}O$ in speleothems as a paleoprecipitation proxy, since during drier periods, when $\delta^{18}O_p$ is high, evaporative enrichment and increased residence time of vadose groundwaters is expected to lead to increased trace element concentrations and a higher excess ^{234}U as a result of recoil and incongruent dissolution. Through this multiproxy approach to paleoclimate reconstruction, there is a strong potential for improvement in the understanding and, hence, applicability of stable isotopic variations in cave calcite deposits.

PP52A-0327 1330h POSTER

The timing and duration of the Last Interglacial Asian Monsoon

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An accurate estimate for the timing and duration of regional and global climate change associated with the Last Interglacial is important for elucidating climate change mechanisms. We present a ^{230}Th-dated $\delta^{18}O$ record of 2 stalagmites (D3 & D4) from Dongge Cave, southern China (25°N, 109°E, an area affected by East Asian & Indian Monsoons), which record Asian Monsoon history over 3 periods, 160-110 ka, 65-43 ka and 15.5 ka - present. The stalagmites have different precipitation environments and water flow paths as indicated by different growth histories, growth rates and $\delta^{234}U$ values. D3 grew faster between 123-118 ka (12 vs. 0.4 cm/ka), but D4 grew faster between 138-126 ka (3.4 vs. 0.7 cm/ka). The mean initial $\delta^{234}U$ value of D3 is -272 (range of -261 to -287). D4 values are higher (mean = -78, range of -27 to -160). Despite these differences, both have similar large $\delta^{18}O$ variations for the interval over which both were active (148 to 113 ka), suggesting that water-rock interactions and kinetic fractionation did not affect $\delta^{18}O$ values significantly.

Dongge Cave stalagmites exhibit features similar to the Younger Dryas (YD) and the Bolling/Allerod as recorded in Greenland ice cores (GISP, 1997) and stalagmites from Hulu Cave, eastern China (Wang et al., 2001). The Dongge YD lies between 12640 +/-140 and 11550 +/-80 years BP, synchronous with Greenland and Hulu Cave YD analogues. Similar to Hulu Cave, light Dongge Cave $\delta^{18}O$ excursions correspond to heavy isotopic excursions in Greenland, consistent with a positive correlation between the intensity of the Asian summer monsoon and Greenland temperature.

The most prominent feature in the Dongge record is a peak that approximates a square wave and is contemporaneous with at least portions of the Last Interglacial sea level high. Dongge Termination II is a large, abrupt negative shift in $\delta^{18}O$ (>3 per mil). The mid-point is at 129.3 +/-0.9 ka, based on direct dating of D4. D3 gives an age indistinguishable from this value. If D4 growth rate is linear over the transition, as implied by long term stable growth rates (from 144 to 124 ka), the transition takes less than 500 y, with most of it taking less than 200 y. The Dongge Last Interglacial also ends with an abrupt $\delta^{18}O$ shift (about 4 per mil). The mid-point is at 119.6 +/-0.6 ka based on direct dating of D3. D4 gives an age indistinguishable from this value. Assuming linear growth, the main portion of the transition took less than 700 y. Combining the onset and end ages of the Dongge Last Interglacial, the duration is 9.7 +/-1.1 ka, from 129.3 +/-0.9 ka to 119.6 +/-0.6 ka, remarkably similar to some estimates of full Last Interglacial sea levels. The timing is broadly consistent with orbital forcing of the Monsoon, although the abrupt shifts require the involvement of other mechanisms (e.g. changes in circulation). Dongge Termination II lags Devils Hole Termination II, some fraction of sea level Termination II, and likely Vostok temperature, Vostok CO_2, and eastern Pacific sea surface temperature. However, there is some evidence that it coincides within error with the final rise in sea level to full Last Interglacial elevations. It may well be that Monsoon Termination II is an orbitally-forced event at the end of a sequence of events not directly caused by orbital forcing. As such it may mark the inception of full interglacial conditions world-wide. Orbital forcing may be necessary for full interglacial conditions, but not for many of the shifts toward interglacial conditions observed to prior to Dongge Termination II.

PP52A-0328 1330h POSTER

Reconstruction of Past Temperatures of Glaciers Subjected to Sub-surface Melting

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Many glaciers are subjected to melting due to high summer air temperatures. Melt water percolates into the snow-firn sequences. Melting intensity during summer months is proportional to the third power of the mean air temperature. Hence, small changes of summer air temperatures induce large changes of the active layer temperatures. The refreezing of melt water results in the sub-surface heat accumulation. The annual intensity of sub-surface heat source is proportional to the melt feature index derived by analysis of extracted ice cores, while the coefficient of this dependence is unknown parameter of the problem. Joint account for the melt feature index and measured oxygen isotopic ratio allowed us to calibrate the paleothermometer, and to compare different climatic proxies. New method for solution of the inverse problems was developed and applied here to reconstruct both the past glacier surface temperatures and time- dependent power of the sub-surface heat source. This mathematical technique allows for finding the unique solution of the problem in the explicit form. The results of temperature reconstructions are in a good agreement with early-obtained data based on the regularization method for the temperatures at the active layer depths. The reconstructions were done for several Arctic ice caps (Austfonna, Akademiya Nauk) and Central Asia mountain glacier (Gregoriev ice cap). The lowest surface temperatures of the Austfonna ice cap occurred during the Little Ice Age, started five hundred years ago. One hundred and fifty years ago the ice temperatures here were colder by 10-11 °C than those that were six hundred years ago. Present ice temperatures are the highest for the last 2000 years. Interpretation of the temperature data is based on comprehensive analysis of various climatic proxies and their mutual calibrations.

PP52A-0329 1330h POSTER

Oxygen and hydrogen isotope compositions of pedogenic phyllosilicates and iron oxyhydroxides: Development of modern surface domain arrays and implications for paleotemperature reconstructions

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Mineralogic, chemical, and oxygen and hydrogen isotope compositions of 68 different modern soil and paleosol phyllosilicate and iron oxyhydroxide samples are presented. The chemical and mineralogic data are used in conjunction with published thermodynamic data to calculate hydrogen and oxygen isotope fractionation factors for each sample. These temperature-dependent fractionation values are then combined with modern global oxygen and hydrogen isotope compositions of meteoric water and temperature data from the IAEA database to construct modern surface domains (MSD) for each phyllosilicate and iron oxyhydroxide sample with the coordinates dD and d18O.

The hydrogen isotopic compositions of the phyllosilicates range from -108 to -24, whereas the oxygen isotopic compositions range from +10.2 to +22.7. The hydrogen isotopic compositions of the iron oxyhydroxides range from -113 to -154, whereas the oxygen isotopic compositions range from +3.1 to -3.2. All of the phyllosilicate samples from modern soils plot within the MSD and yield equilibrium temperatures of formation similar to measured temperatures at each respective site. These results suggest that published thermodynamic data provide good estimates of natural systems. Paleo-equatorial Permo-Pennsylvanian phyllosilicates and iron oxyhydroxides plot within the MSD, or at slightly higher temperatures than MSD values (25 to 35°C). Eocene kaolinites plot within the MSD with equilibrium temperatures above modern temperatures (22°). Late Triassic iron oxyhydroxides from Argentina

plot within the modern surface domain at temperatures of 12°C. However, the phyllosilicate data points plot well outside their respective MSDs, suggesting the phyllosilicate δ D values of these Triassic samples have likely been altered by proton-diffusion.

PP52A-0330 1330h POSTER

Stable Isotopes in Precipitation in the Canadian Rockies: Implications for Meteorological Controls on Annual Snowpack

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Fresh snow and rainwater samples were collected in February, March, and August 2002 at elevational transects extending from 1800 to 2900 m in the Haig Icefield region, southern Canadian Rockies. The Haig Icefield straddles the continental divide and its principal outlets drain into eastern and northern slopes of the Upper Kananaskis, French, and Robertson valleys. Both eastern and northern drainages are considered to be lee slopes with respect to the prevailing westerlies that bring moist Pacific air masses into the region. Snow and rain samples were analyzed for oxygen and hydrogen isotopes as a function of altitude, revealing opposite elevation-depletion relationships in different precipitation events. We interpret the results in relation to synoptic meteorological conditions during each event. Different synoptic systems have distinct isotopic signatures in the region. Snow samples were also collected from snowpits at three different sites, providing a stratigraphic record of isotopic content through winter 2001/2002. Isotopic variability allows us to assess the synoptic controls on seasonal snowpack in the region. This offers a promising avenue for improved understanding of moisture supply and its sensitivity to interannual variations in weather system frequency.

PP52B MCC: 131 Friday 1330h

Advances in the Development and Application of Paleoproxies II *(joint with A, H, OS, GC)*

Presiding: **G Klinkhammer,** Oregon State University**; P K Swart,** University of Miami

PP52B-01 1330h

Temperature-Dependent Ca Isotope Fractionation in Calcitic Phyto- and Zooplankton (*Emiliania huxleyi* and *Orbulina universa*)

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Coccolithophores are important primary producers and are responsible for approximately half of the global carbonate precipitation. Their first occurrence dates back to the Triassic, thus, providing the potential to record long-term changes in ocean chemistry.

Here we report results of δ^{44}Ca analysis of the coccolithophorid *Emiliania huxleyi* grown in mono-specific cultures at temperatures ranging between 5 and 20°C. The temperature-dependence of Ca isotope fractionation in *E. huxleyi* is 0.042 $\pm$ 0.005$^o/_{oo}$ /°C which is similar to the planktic foraminifera *O. universa* (0.019 $\pm$ 0.002$^o/_{oo}$/°C) (Gussone et al. 2002). The observed Ca isotope fractionation ($\epsilon_{calcite-fluid}$=-1.1$^o/_{oo}$, 15°C) is in general agreement with a previously published value of cultured *E. huxleyi* at 16°C (DeLaRocha and DePaolo 2000). In contrast, Quarternary coccolith oozes show considerably lighter δ^{44}Ca values ($\epsilon_{calcite-fluid}$ =-1.9 to -2.6 $^o/_{oo}$) (Zhu and McDougall 1998). The origin of this discrepancy is not yet clear. It may be due to culturing artifacts, diagenetic alteration or species-dependent Ca isotope fractionation.

The fractionation of Ca isotopes in calcite is similar in *E. huxleyi*, *O. universa* and sclerosponges (*Spirastrella* (*Acanthochaetetes*) *wellsi*). In contrast, Ca isotopes in inorganic aragonite and aragonitic sclerosponges (*Ceratoporella nicholsoni, Astrosclera willeyana, Vaceletia sp.*) are more strongly fractionated ($\epsilon_{aragonite-fluid}$ =-1.7$^o/_{oo}$, 15°C). These observations indicate that kinetic Ca isotope fractionation during calcium carbonate precipitation depends *inter alia* on the skeleton mineralogy of marine organisms. The latter effect has to be explained by a model of kinetic isotope fractionation taking the specific mineralogical differences between calcite and aragonite into account.

References

DeLaRocha, C.L. and DePaolo, D.J., Science, **289**,1176-1178, 2000

Gussone, N., Eisenhauer, A., Dietzel, M., Heuser, A., Spero, H., Bijma, J., Böhm, F., Nägler, Th. F., Geophysical Research Abstracts **4**, 2002 (EGS02-A-02944)

Zhu, P. and McDougall, J.D. Geochimica et Cosmochimica Acta **62**, 1691-1698, 1998

PP52B-02 1345h INVITED

Paleoproxies: Heavy Stable Isotope Perspectives

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Recent advances in isotope ratio mass spectrometry, namely multiple collector ICP-MS and refined TIMS techniques, will significantly enhance the ability to measure heavy stable isotope fractionation, which will lead to the development of a wide array of process-identifying (bio)-geochemical tools. Thus far research in this area is not easily assessable to scientists outside the isotope field. This is due to the fact that analyzing heavy stable isotopes does not provide routine numbers which are per se true (the preciser the truer) but is still a highly experimental field. On the other hand resolving earth science problems requires specialists familiar with the environment being studied. So what is in there for paleoceanographers?

In a first order approach, relating isotope variations to physical processes is straightforward. A prominent example are oxygen isotope variations with temperature. The total geological signal is of course far more complicated. At low temperatures, heavy stable isotopes variations have been reported for e.g. Ca, Cr, Fe, Cu, Zn, Mo and Tl. Fractionation mechanisms and physical parameters responsible for the observed variations are not yet resolved for most elements. Significant equilibrium isotope fractionation is expected from redox reactions of transition metals. However a difference in coordination number between two coexisting speciations of an element in the same oxidation state can also cause fractionation. Protonation of dissolved Mo is one case currently discussed. For paleoceanography studies, a principal distinction between transition metals essential for life (V to Zn plus Mo) or not will be helpful. In case of the former group, distinction between biogenic and abiogenic isotope fractionation will remain an important issue. For example, abiotic Fe redox reactions result in isotope fractionations indistinguishable in direction and magnitude from microbial effects. Only a combination of different stable isotope systems bears the potential to solve this problem for a given set of samples and thus to model the ocean system more accurately in different scales.

Besides all complications some important applications of heavy stable isotopes as paleoproxies already emerge. Pilot studies indicate that Mo isotopes may present a proxy for the extend of anoxic condition in past oceans. On a finer scale the same system appears to provide a measure of (bio)-chemical redox-changes related to diagenesis. The Ca isotope system may complement more classical sea surface temperature proxies in particular environments. Promising results exist for polar waters (N. pachy left), as well as indications on the seasonality under global greenhouse conditions 110-50 Ma ago. However, the heavily species dependent Ca isotope fractionation can not be interpreted by just adopting concepts and findings from the oxygen system. While a complication to the ease of use as SST proxy, this species dependence offers pathways to unravel different modes of bio-calcifications.

Given the complexity of the matter, collaboration of specialists of different fields will be needed to develop successful process-related hypotheses and diagnostic tools.

PP52B-03 1400h

Do geochemical and faunal estimates of upper-ocean temperature agree in the tropics? Yes and no.

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To test geochemical and faunal proxies for upper-ocean paleotemperatures, we developed a uniform data set of multiple proxies in a core from the equatorial cold tongue in the eastern tropical Pacific over the past 25,000 years. The proxies are Mg/Ca on surface-dwelling G. ruber (using the time-resolved sequential leach procedure of Haley and Klinkhammer, 2002, and Benway et al., 2002, and the temperature calibration of Dekens et al., 2002), the alkenone index Uk'37 (using the temperature calibration of Prahl et al., 1988), traditional faunal transfer functions based on radiolarians (Pisias et al., 1997), and a revised faunal transfer function method for foraminifera (Mix et al., 1999). To first approximation, all the methods agree within their calibration uncertainties that temperatures in the eastern Pacific cold tongue varied by 3-5 degrees C from glacial-to-interglacial time. In detail, however, the methods disagree. For example, the two geochemical methods bracket the range of total change, with largest changes in Mg/Ca (6 degrees) and smallest changes in Uk'37 (3 degrees). The radiolarian and Uk'37 indices stay relatively cold through the deglaciation and warm in the early Holocene, whereas the foraminiferal and Mg/Ca indices document warming relatively early following the Last Glacial Maximum. The differences in timing of changes occurs over a 1 meter interval of the core, and thus are not an artifact of differential bioturbation. We explore the potential causes of offsets between the indices, based on the ecological preferences of the carrier particles and other possible effects.

PP52B-04 1415h

Sr/Ca in Coral Aragonite: Is Night Carbonate a Good Indicator of Sea Surface Temperatures?

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Sr/Ca in coral skeletons has potential as an indicator of past seawater conditions but exhibits geochemical heterogeneity on a small spatial scale (<100 μm) that does not reflect variations in sea surface temperature (SST) or chemistry. Skeletal Sr/Ca is affected by variations in skeletal calcification rate which may be dependent on the photosynthetic activity of the zooxanthellae in coral tissue. The skeleton deposited at night may be unaffected by these variations and may be a more reliable indicator of SST (Cohen *et al.* 2001).

We used secondary ion mass spectrometry with a 10 μm diameter analysis spot to construct records of Sr/Ca in a *Porites lobata* specimen from Lanakai, Oahu, Hawaii. Analyses were performed on sections cut perpendicular to the growth surface of the coral skeleton, spanning annual bands. Parallel tracks were analysed following fasciculi (composed of acicular crystals deposited during the day) and centres of calcification (composed of fusiform crystals deposited at night).

The Sr/Ca of the day and night material follow similar seasonal trends but are offset with night carbonate typically enriched by 0.3-0.4 mmol mol^{-1}. Both profiles are characterised by large Sr fluctuations of 0.4-0.5 mmol mol^{-1}, which are deposited approximately days apart and are superimposed on the general Sr seasonal trend. These fluctuations do not reflect variations in SST but may relate to daily variations in coral calcification or linear extension rate both of which can vary markedly during the day and night. We conclude that night carbonate **is** affected by kinetic processes and that there are similar challenges in reconstructing SST records from night carbonate as from day carbonate.

Cohen AL *et al.*, Kinetic control of skeletal Sr/Ca in a symbiotic coral: implications for the palaeotemperature proxy, Paleoceanography, 16, 20-26, 2001.

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