OS11A-06 0915h

Relationships Between Early Diagenetic Processes, Carbon Remineralization, and Sedimentary Dynamics in the Gulf of Papua Deltaic Complex

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A range of diagenetic environments is found within the central Gulf of Papua clinoform, each characterized by different balances between sedimentary dynamics, net accumulation, physical and biogenic transport processes, and biogeochemical properties. Sediments are generally diagenetically reactive, with ΣCO_2 production and benthic O_2 fluxes typically ranging between 10 - 40 mmol / m^2 / d (upper 20 cm). Highest remineralization rates occur within mobile inner topset and channel muds (1-20 m depth) and in the high accumulation rate rollover region of the topset - foreset beds (40-50 m). Lowest rates are found inshore along sandy channels, middle topset, and the deeper foreset (75 m). Topset deposits are typically suboxic, nonsulfidic over the upper ~0.2 - 1 m, due to various combinations of physical reworking and deep bioirrigation. Pore water sulfate can be measureably depleted at depths > 0.3 m, however dissolved sulfide remains below detection (upper ~1-2 m). Sedimentary C / S ratios are ~4 - 6 within the topset regions but decrease to < 3 in offshore foreset beds and inshore mud banks where sulfidic diagenesis dominates. Remineralization patterns are independent of relative abundance of terrestrial or marine sedimentary carbon, both are efficiently remineralized. C_{org} isotopic analyses (^{13,14}C) demonstrate that although terrestrial sources can be primary substrates at inshore sites, young marine C_{org} preferentially dominates pore water ΣCO_2 relative to bulk C_{org} in the upper foreset A small quantity of young, rapidly recycled marine organic material is often superimposed on a generally older, less reactive terrestrial background.

OS11A-07 0930h INVITED

Geochemical Budget for Barium on the Wet Tropical Continental Shelf & Slope of the Gulf of Papua, Papua New Guinea.

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Most of the riverine supply rate of Ba to the Gulf of Papua from wet tropical mountains and coastal plains of southern New Guinea is in particulate form. Freshwater dissolved Ba concentrations are low (60 nM), but increase by 4-5 times in the salinity gradient of the upper deltas. This salinity enhanced dissolved Ba may come from suspended and bottom sediment cation exchange, or from groundwater inputs. Ba is also supplied to the water column of the inner shelf from sediment pore water diffusion. The distribution of shelf and slope sedimentary concentrations of Ba is presented, along with estimates of sediment mass accumulation rates from core profiles of excess 210Pb and 137Cs. We estimate that century scale burial of Ba on the inner shelf is less than 25% of total Ba supply from rivers, the remainder being exported to the northern Coral Sea and the New Guinea Coastal Current. Ba removal rates in the northern Coral Sea, as estimated from sediment traps and a few cores, are small but cover a large area. Maximum Ba concentrations in sediment are found in deep (greater than 2000 m) water of the northern Coral Sea, where sediment accumulation rates are very low. Variations in sediment core Ba profiles appears to be due to variations in the ratio of supply rate of river aluminosilicate minerals to marine carbonate supply, and not easily related to a proxy for productivity.

URL: http://www.aims.gov.au/tropics

OS11A-08 0945h INVITED

Platinum Group Element Fractionations in Sediments in the Gulf of Papua, New Guinea

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The elemental concentration pattern for the platinum group elements (PGEs), and their periodic table neighbors Au and Re in modern seawater, is highly fractionated relative to their proportions in the upper continental crust, mantle or meteorites. This may be due to a combination of factors, including chemical weathering and estuarine fractionations. As yet little is known about the geochemical behaviors of the PGEs in estuaries. Because of the importance of the wet tropics in contributing solutes and sediments to the oceans, the Gulf of Papua is a good location to investigate PGE fractionations. The Fly River is one of the largest rivers draining into the Gulf of Papua and is and among the world's top rivers in terms of discharge and sediment yield. By analyzing both the source (river sediment) and sinks, we can begin to understand both the on-land and estuarine fractionations that take place in this system. We have measured the concentrations of Pt, Pd, Ir and Os in surface sediments from the Gulf of Papua, New Guinea and compare these to the concentrations and concentration ratios of Os/Ir and Pt/Pd in Fly River sediment. The Os/Ir of sediment from the upper Fly River is ~4. This value is elevated in comparison to the crust, mantle and meteorites, all of which have Os/Ir of about 1. By contrast, the Os/Ir ratio of seawater is approximately 110. Sediments in the Fly River Delta and Gulf of Papua have Os/Ir ratios that are all lower than the upper Fly River, and may indicate that Ir is preferentially scavenged in the oxic sediments that are typical of the Gulf of Papua. Although a correlation between organic carbon and Os burial was previously indicated, the Ir concentrations do not appear to be correlated with the organic carbon. In the central Gulf, farther from the influence of the Fly river and nearer to the Purari and Kikori Rivers, both of which may have a larger ultramafic component in their catchments, the Os/Ir ratio in the sediments approaches the mantle value of 1, indicating a predominance of a detrital source in those sediments. The other sediments in the Gulf of Papua are interpreted to have been affected by variable amounts of oxic scavenging. Preferential removal of Ir in the estuarine environment can help to explain the extremely elevated Os/Ir of seawater. Although the variations are more subtle for Pt/Pd, there is evidence of preferential removal of Pd relative to Pt in the estuarine and marginal marine sediments. The relatively high Pt/Pd in seawater (~3) compared to the crust (~ 1.8) can be explained by oxic scavenging of Pd in sediments such as those in the Gulf of Papua.

OS11B MCC: 3000 Monday 1020h

The Arctic and North Atlantic Oscillations: Past, Present, and Future I *(joint with A, H, PP, C)*

Presiding: **D A Darby,** Old Dominion University**; L Mysak,** McGill University

OS11B-01 1025h

Variability in Summer Arctic Temperature and Arctic Oscillation Over the Past 600 Years

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Spatial arrays of high-resolution (annual-decadal) paleoclimate records from throughout the Arctic were used to distinguish different modes of variability and trace their behavior back in time. A previous compilation of primarily annual-resolution records provided a view of average Arctic summer temperature during the past 400 years, documenting dramatic 20th-century warming that ended the Little Ice Age in the Arctic and caused dramatic retreats of glaciers, melting of permafrost and sea-ice, and alteration of terrestrial ecosystems. Some evidence suggests that these recent changes may be linked to an increasing positive phase of the Arctic Oscillation (AO), and that this trend in the AO itself may theoretically be due to greenhouse warming. Multi-century records of temperature and AO behavior are needed to identify natural background variability and evaluate potential linkages. A new international collaboration has created a spatial array of high-resolution Arctic paleotemperature records for the past 600 years. Annually resolved archives were used wherever possible (e.g., tree rings, varved lake sediments, and annual ice layers), but sub-decadal resolution records from ice cores and high deposition-rate lake and marine sediments were included as well. Empirical Orthogonal Function (EOF) analysis was used to characterize the spatial and temporal modes of variability contained in the proxy array. The three leading modes of proxy variability all have highly significant correlations to the three leading modes identified in NCEP-NCAR reanalysis data, and are associated with dynamically significant processes, including: 1) a circum-Arctic average temperature trend with rapid 20th-century warming; 2) the Arctic Oscillation; and 3) a Urals Trough wave number three circulation pattern. Our analyses demonstrate the ability to identify the major modern observed modes of Arctic SAT variability within an array of proxy data, and reconstruct these modes back in time. These results provide insight into the long-term natural background variability of the AO and its relation to average Arctic temperature, and place their recent positve co-variation into a pre-anthropogenic context.

URL: http://www.ncdc.noaa.gov/paleo/parcs/hi_res_whoi.html

OS11B-02 1040h

A Holocene Record of Changing Arctic Surface Ice Drift, Analogous to the Effects of the Arctic Oscillation

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The Arctic Oscillation (AO) controls the strength and location of the Trans Polar Drift (TPD), a system that exports ice through Fram Strait into the Nordic Seas. There, changing amounts of sea ice influence surface water salinity and the formation of North Atlantic deep water (NADW), and this, in turn has an impact on the global climate. Therefore, in order to understand how the global climate system functions it is imperative to know how the TPD changed over the last millennium or more. To that end we performed a provenance study on ice rafted sand grains in a sediment core located near the confluence of the counterclockwise TPD and the clockwise Beaufort Gyre. The core has more than 200 cm of Holocene sediment with intervals dominated by grains from the Siberian shelves alternating with intervals of abundant grains from North American sources. Grains matched to Siberian shelves indicate that the TPD was shifted toward North America similar to what occurs during a more positive phase of the AO. This scenario alternated with intervals where few grains matched to Russian sources. During the last 1300 years increased influx of Russian grains occurred approximately every 50-150 years. We suggest that this periodicity represents the long-term fluctuation of the AO, which produces the same TPD shift today. In addition, we found evidence for ice drift changes corresponding to the Medieval Warm interval from 900-1200 AD and at the end of the last deglaciation when glacial iceberg rafting rapidly declined. These more recent changes prior to the Little Ice Age were opposite in sense to the mineralogic changes at the last termination, and might indicate changes leading to the onset of the Little Ice Age.

OS11B-03 1055h INVITED

AO/NAO Patterns in the North Atlantic - Arctic Ocean?

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There is little question that on annual to possibly decadal time scales, the AO/NAO has an important influence on climate of the Arctic Ocean and northern North Atlantic; however, it has been widely debated whether the same is true on much longer time scales of multi-centuries to millennia. Some authors claiming NAO dipole or tripole patterns on those time scales in the northern North Atlantic have refuted those claims in later publications. Adding to the problem is the possibility that reduction in thermohaline overturning, local buildup of sea ice, or response to solar variations might produce patterns similar to those of the NAO. Certainly, it is far from clear how a pattern resulting purely from atmospheric forcing can be maintained on long time scales. A compilation of temperature-related records spanning most or all of the Holocene together with new data from cores our group has analyzed does not appear to produce geographic patterns of temperature change that are consistent with the AO/NAO. Those records extend from the Laptev Sea to about 40 degrees N in the North Atlantic and are, with the exception of the Laptev Sea, from the open ocean. The sense of temperature change appears to be the same at all of the coring sites; that is, there is no evidence of multipole patterns. Records from the Labrador Sea and from near-shore areas off the Scotian margin, however, exhibit more complicated patterns, but still not those expected from the AO/NAO. In those more restricted areas, the complicated patterns may reflect local climate dynamics and/or the influence of sea ice cover on near surface ocean temperatures.

OS11B-04 1110h

Orographic and Geographic Constraints on a Modeled Siberian Snow - Arctic Oscillation Teleconnection Pathway

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Land surface anomalies have recently been recognized as influential to the Arctic Oscillation (AO), and thus represent a potentially important but relatively untapped research direction, with possible ramifications for seasonal prediction. Previous publications by the authors have identified a surface-troposphere-stratosphere teleconnection pathway linking observation-based early season Siberian snow perturbations to a modulation of the winter AO mode. In this study, the key roles of orography and geography in producing this modeled teleconnection is explicitly investigated using numerical GCM experiments. First, the climatic response to the same snow perturbation is compared between observed and suppressed orographic barriers in southern and eastern Siberia. Second, the AO mode response to realistic land surface snow forcings is evaluated for two different forcing regions, Siberia and North America. Results indicate that the combination of a large snow-forced local diabatic heating anomaly over a region of substantial (orographically-forced) stationary wave activity is required to produce strong upward wave activity flux anomalies which initiate the teleconnection pathway. These features are unique to Siberia, making it a critical region for reproducing the snow - winter AO statistical relationship evident in the observational record, and potentially for improving seasonal prediction of the winter AO mode.

OS11B-05 1125h

From NAO to AO: A distinctive process between two phenomena

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Toward understanding the physical origin of the so-called Arctic Oscillation (AO), we performed a singular vector analysis to the dynamical operator of the primitive model linearized about winter 3D state. The leading singular mode having the longest lifetime resembles, though not perfectly, the AO in many aspect, suggesting that the AO is a dynamical mode of the northern winter atmosphere. Furthermore, the evolution of the mode reveals the Atlantic signal rapidly propagating to East Asia along the jetstream, reminiscent of stationary Rossby waves trapped on the jet waveguide. Analysis of monthly observed fields does indicate that the North Atlantic Oscillation (NAO) accompanies such a zonally oriented wavetrain in late winter, when the NAO is virtually indistinguishable from AO. Thus the energy propagation along the Asian jet waveguide appears one of processes which realize the regional NAO extending toward the hemispheric AO.

OS11B-06 1140h INVITED

Predicting the Extent of Summer Sea Ice in the Arctic

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The summers of 1998 and 2002 had the least sea ice extent (SIE) in the Arctic. These observations seem to agree with the trends noted by Parkinson, et al. (1999, hereafter P99) for the period 1979-1997, but the spatial pattern of these recent decreases in summer SIE were different. The summer trends shown by P99, exhibit large decreases in SIE primarily in the East Siberian Sea (ESS), while the decreases observed during 1998 and 2002 were much larger in the Beaufort and Chukchi seas (BCS). We now show that the trends for the period 1979 - 2002 are much smaller in the ESS than the trends shown by P99, and the largest decreasing trends have shifted from the ESS to the BCS. Rigor, et al. (2002) showed that the changes in SIE that P99 noted were driven by changes in atmospheric circulation related to the phase of the prior winter Arctic Oscillation (AO, Thompson and Wallace, 1998) index. Given that the latest trends in SIE are different than those shown by P99, one could ask whether the affect of the AO on sea ice noted by Rigor, et al. (2002) has also changed, and whether some large scale climate modes other than the AO has influenced the climate of the Arctic Ocean more? To answer these questions, we applied Empirical Orthogonal Function (EOF) analysis on the September SIE data from microwave satellites, and found that the first two modes SIE were most highly correlated to the prior winter AO, and the AO index of the summer months just prior to each September. These modes explain more than 45% of the variance in SIE, and show that the influence of the winter and summer AO dominates Arctic climate from 1979 - 2002. Using data from the International Arctic Buoy Programme and the National Centers for Environmental Prediction, we will show that the changes in sea ice extent are primarily driven by dynamic changes in sea ice thickness and discuss the implications for predicting summer SIE.

URL: http://iabp.apl.washington.edu/SeaIceAO/

OS11B-07 1155h INVITED

Freshwater Budget of the Arctic and High Latitude Modes of Atmospheric Variability

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A simple model simulating the basin-scale barotropic response of the Arctic Ocean to changes North Atlantic Oscillation (or Arctic Oscillation) is presented. The model distills concepts developed by Hunkins, Proshutinsky and others into an anylitic calculation of the balance between inputs of vorticity to the surface of the Arctic Ocean and their dissipation within the Ocean-Ice system. The results of the model are compared with tide-gauge data from various coastal stations and with a new synthesis of isotope tracer data collected during the last 15 years. The observations and theory are applied to the problem of freshwater storage in and export from the Arctic Ocean. Using this simple model, preliminary 3-D coupled ice-ocean model simulations, (validated against tracer and sea-surface height observations) we discuss potential links between atmospheric variability, Arctic Ocean dynamics and the export of freshwater to the Nordic Seas.

OS11B-08 1210h

Decadal Variability of Circulation in the Arctic Ocean Retrieved From Climatological Data by Variational Method

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An inverse 3D finite-element ocean circulation model has been designed and used to study variability of the Arctic Ocean circulation in the last four decades. We obtained stationary model solutions with the temperature and salinity fields close to the ones given in the Environmental Working Group (EWG, 1998) Atlas. Transports at the open boundaries, wind forcing and hydrographic fields are treated as unknowns, which are varied to minimize a quadratic cost function subject to model constraints. The inverse problem is solved for ten gridded hydrographic data sets that were obtained as winter and summer averages of EWG data over each of the four decades (50's to 80's) and over the whole period of observations (1948–1993) documented in the Atlas. The results show that Arctic circulation in the last four decades has undergone significant changes, which manifest themselves in a) 10% reduction of the ventilation rate in the Atlantic sector of the Arctic Ocean; b) substantial decrease of the advective heat and freshwater import at the lateral boundaries; c) spinning down of the cyclonic gyre in the northern Greenland sea, which is partly driven by deep convection; d) 3400 km^3 increase of the net fresh water storage, with 75% taking place in the Atlantic sector of the Arctic Ocean. Most of these changes are similar to the ones observed on seasonal transition from winter to summer climatologies, and indicate that Arctic Ocean is experiencing a shift towards a warmer state.

OS12A MCC: Level 1 Monday 1330h

Geological and Biogeochemical Processes in a Wet Tropical Setting: New Guinea, Source to Sink II Posters *(joint with B, H)*

Presiding: **R C Aller,** State University of New York at Stony Brook**; C A Nittrouer,** University of Washington

OS

OS12A-0183 1330h POSTER

Benthic Communities as Indicators of Geological and Biogeochemical Processes in the Gulf of Papua

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Benthic communities inhabiting Gulf of Papua deposits play important roles in determining remineralization and material cycling processes at the seafloor. Faunal abundances, size-frequency distributions, functional groups, and vertical distributions reflect a spectrum of diagenetic depositional environments produced by variations in local sediment transport dynamics and coastal morphology. Thus faunal properties provide a basis for comparison of factors influencing sediment - overlying water interactions, elemental cycling, and material storage. During mid NW monsoon periods (Jan-Feb), macrofaunal densities at Gulf stations are generally low (260 to 1270 m^{-2}), large macroinfauna are absent in the upper ~25 cm, and small (< 0.5 mm) surface deposit-feeding polychaetes and tubiculous amphipods dominate, reflecting a frequently destabilized