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Hydrogeology • Mineral Resources Waste Management • Geological Engineering • Mine Hydrology

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Mr. Fred Ross
Division of Waste Management
Mail Stop 623-SS
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Fred:

I have enclosed copies of the GSA abstracts that I mentioned in our phone conversation today. These abstracts are interesting with respect to the possibility that an alternate groundwater flow system model may be valid in the Gulf Coast sediments associated with the salt domes.

Sincerely,

Gerry

Gerry Winter

2351

INCREASING EVIDENCE FOR GRAPHITE AS A PRIMARY PHASE IN MANY LARGE MAFIC PLUTONS

Nº 27870

ULMER, Gene C., Department of Geology, Temple University, Philadelphia, PA 19122

Graphite/carbon has recently been reported in large portions of the stratigraphy of the Skaergaard (Sato & Valenza, 1980), of the Bushveld (Elliott et al, 1982), of the Stillwater (Volborth and Housley, 1983), and of the Laramie Anorthosite (Frost & Lindsley, personal communication). Additionally, narrow stratigraphic zones of graphite associated with mafic silicates and platiniferous sulfides are famous ores in the Bushveld and Stillwater (op. cit.) and are also known for example in the Ural Mtns, Norilsk District (Genkin, 1970); in an ophiolitic complex in Zambales, Philippines (Abrajano and Bacata, 1982); in ophiolitic alpine peridotites in Labrador and Newfoundland (Ian Mason, personal communication) and in several serpentinites of Austria (Stumpfl, personal communication).

Preliminary data from stepwise pyrolysis and reconnoissance work with intrinsic oxygen fugacity measurements all substantiate the textural evidence that most of this graphitic carbon is primary. For example, in oxides and silicates in the Bushveld Merensky Reef, from 84-1835 ppm of non-organic, non-carbonate carbon is detected with pyrolysis above 1000ºC. Again in the Bushveld, silicate and oxide fO_2 data from 750º to 1150ºC show no re-equilibration with the graphite. The 1150ºC values of $-\log fO_2 \geq 13.8$ for some 600 meters of the Bushveld Critical Zone. This graphite is therefore in equilibrium with the silicates and oxides, i.e., there was primary carbon buffering.

The provenance of this carbon is not certain; it may be mantle-derived, sedimentary footwall derived, or metamorphically added, but the graphitic carbon is not biological contamination. Similar studies need to be done on other plutons. At these low fO_2 values, sulfide immiscibility is enhanced, hence the graphite-sulfide associations.

SULFIDE MINERALIZATION IN THE WINNFIELD SALT DOME, LOUISIANA

Nº 32087

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The Winnfield salt dome is a shallow piercement dome within Cretaceous siliciclastic and carbonate strata in the North Louisiana Basin. Quarrying operations in the cap rock have exposed zones of metal sulfides. Sulfides observed during field and petrographic study are, in order of decreasing abundance; pyrrhotite, marcasite, pyrite, galena and sphalerite. Barite is frequently associated with the sulfides. Sulfide minerals occur as: (1) thick, roughly-layered massive-sulfide lenses in troughs at the anhydrite-calcite contact; (2) veinlets in anhydrite, gypsum and calcite, filling fractures and permeable zones commonly parallel to the stratified host; and (3) massive sulfide mounds in anhydrite, filling open-space and replacing brecciated anhydrite. Euhedral to subhedral pyrrhotite, typically ranging from 0.1 to 8 mm in length, is the dominant sulfide in the anhydrite portion of the cap rock. Intergrown masses of cryptocrystalline marcasite and pyrite are more abundant at the anhydrite-calcite contact. Galena and sphalerite were precipitated late in the mineralization history occurring at the top of the massive sulfide lens and in cross-cutting fractures and as overgrowths on pyrrhotite. Sulfur isotopic values for the sulfides range from +9.1 to -23.7‰ $\delta^{34}S$. $^{206}Pb/^{204}Pb$ for galena is 18.69.

The mineralization process at the Winnfield salt dome is believed to have been similar to that of Mississippi Valley-type Pb-Zn deposits. Basinal brines carrying metallic complexes were expelled upward along the salt stock margin as a result of lithostatic loading; fractures produced during salt dome piercement provided access for the brine to the cap rock. Metallic sulfides were precipitated as a result of mixing with reduced sulfur generated by sulfate-reducing bacteria in the cap rock.

PROVENANCE OF FRANCISCAN AND RELATED SANDSTONES OF NORTHERN CALIFORNIA, WITH IMPLICATIONS FOR SEDIMENT DISPERSAL DURING THE TERTIARY

Nº 19832

UNDERWOOD, Michael B., Dept. of Geology, University of Missouri, Columbia, MO. 65211

Petrographic data from sandstone suites collected in the Garberville-Pt. Delgada region of northern California demonstrate that multiple source terranes supplied detritus to the Franciscan subduction complex during the Tertiary. Several distinct petrofacies are evident within the Coastal Belt Franciscan alone, including suites dominated by volcanic lithics, sedimentary lithics, and quartz/plagioclase/K-feldspar. The volcanic debris probably originated in the Paleogene magmatic arc of southern Idaho or the Sierra Nevada arc system, while the sedimentary rock fragments were likely eroded from Franciscan/Great Valley strata, perhaps via local submarine activity. A plutonic provenance is required for the bulk of Coastal Belt strata, however, with the Sierra Nevada-Idaho batholith trend the most logical source. Subarkosic sandstones of the Yager "formation" also reflect a strong plutonic provenance. Strata of the King Range "terrane" yield some samples with elevated quartz values. As a group, however, there is considerable overlap between this suite and both the Coastal Belt and Yager; a similar plutonic provenance is therefore envisioned. Finally, Neogene forearc deposits of the Wildcat Group were derived almost exclusively from uplifted sedimentary strata of the northern Coast Ranges. Significantly, the Klamath Mountains appear to have been relatively inconspicuous as a source for any of the rock units examined.

These data are important for models of paleogeography and sediment dispersal during the Tertiary. A combination of transverse and longitudinal transport is favored for the Coastal Belt and King Range, while Yager and Wildcat basins were probably fed by transport systems that were oriented roughly east to west. Along-strike variations in the plutonic source terrane are also inferred.

AN ARCHEAN ANALOG FROM NEWFOUNDLAND AND ITS BEARING ON THE ORIGIN OF ANCIENT GREENSTONE BELTS

Nº 30979

UPADHYAY, H. D., Department of Earth Sciences, Northeastern Illinois University, 5500 N. St. Louis Ave., Chicago, IL 60625

Archean greenstone belts, whose tectonic origin continues to be a subject of debate (Condie, 1981), have very few Phanerozoic counterparts. New information on the geology of Burlington Peninsula, Newfoundland shows that this region possesses many striking similarities with Archean terrains, some of which are as follows: 1) Archean high-grade metamorphic terrain and the low-grade greenstone-granite association are represented, respectively, by the Precambrian-Cambrian Fleur de Lys Supergroup (plus the Grenvillian basement gneisses) and the Lower Ordovician Baie Verte-Betts Cove ophiolites, the latter associated with various granitic bodies. 2) The Fleur de Lys terrain contains polydeformed psammitic mica-garnet-kyanite-and staurolite-schists; the ophiolites show greenschist facies metamorphism and moderate deformation. 3) The outcrop configuration is similar to those of many Archean terrains, e. g., the ophiolites occur as linear belts, forming limbs of two separate, tight synclines. 4) Komatiitic lavas, confined almost entirely to the Archean, are also known from both of these ophiolites. 5) Consdierable amounts of graywacke, argillite, and chert are associated with the ophiolites. 6) The Archean "gneissic complex" is represented by the Burlington Granodiorite, probably related to an Ordovician island arc. 7) The "post-tectonic granite" of the Archean can be equated with the Silurian Cape Brule Porphyry of Burlington Peninsula.

The ophiolite suites of Burlington Peninsula represent Appalachian oceanic crust and mantle. Most data is consistent with their origin in a back-arc setting above a subduction zone (Upadhyay & Neale, 1979). A marginal basin-island arc setting, therefore, appears to be plausible for the genesis of Archean greenstones, as had also been suggested from the Cretaceous "Roca Verdes" of southern Chile (Tarney et al, 1976).

EPIDOTE-BEARING PERALUMINOUS GRANITOIDS OF THE NORTHERN ALABAMA PIEDMONT

Nº 31718

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The Pinckneyville Complex of the Northern Alabama Piedmont contains moderately to strongly peraluminous trondhjemites and granites which exhibit both S-type and I-type characteristics. S-type aspects include the presence of modal muscovite and garnet, greater than 1.1% CIPW normative corundum, and the presence of biotite-rich segregations in a leucocratic matrix. I-type characteristics include a broad range of silica contents (62-76%), linear inter-element correlations (at 99% confidence level) among SiO_2, Al_2O_3, TiO_2, FeO, MgO, CaO, K_2O and P_2O_5, and the presence of sphene rather than ilmenite as the dominant Ti-bearing phase. Na_2O contents are variable and range up to 5%; petrographic evidence indicates that this is in part due to secondary albitization of plagioclase.

Euhedral epidote, present in both trondhjemites and granites, is typically associated with sphene and rimmed by primary biotite. Mass balance calculations indicate that the epidote and sphene may have formed through the breakdown of early magmatic hornblende, by reactions such as HBL + KSP + AN + MT = BIO + EPI + QZ (Zen, 1982), or HBL + KSP = BIO + EPI + SPH + AB + MUS + QZ. The total lack of hornblende in granitoids of the Northern Alabama Piedmont, however, suggests that amphibole never formed, and that epidote and sphene crystallized directly from the granitic magmas.

ORIGIN OF METALLIC SULFIDE DEPOSITS IN GULF COAST SALT DOME CAP ROCKS

Nº 32086

PRICE, Peter E., Marathon Oil Company, Denver Research Center, Littleton, CO 80160; and KYLE, J. Richard, Department of Geological Sciences, University of Texas at Austin, Austin, TX 78712

Gulf Coast salt domes are the focus of many processes yielding economic deposits or accumulations of minerals and hydrocarbons. Salt, sulfur, gypsum, anhydrite, limestone and uranium are commodities that have been produced from salt domes or the salt dome environment. Recent exploration at Hockley Dome, Harris Co., Texas, indicates that this environment is also capable of producing significant concentrations of metals. Sixty-five core tests indicate an annular zone of metallic sulfides around the perimeter of the cap rock. Concentrations of iron, lead, and zinc sulfides in this zone range from trace amounts to over 50% in both calcite and anhydrite components of the cap rock. Significant concentrations of barite and silver have also been identified. Petrographic, isotopic, trace element, and biological information supports origin of the deposit through a complex evolutionary system involving halokinesis, cap rock development and diagenesis, and basinal brine formation and migration. $^{206}Pb/^{204}Pb$ for galena (7 samples) ranges from 18.73 to 18.79 and is similar to modern Gulf Coast lead-rich formation waters. $\delta^{34}S$ for sulfides (40 samples) show a wide range from -19.2 to +4.0 ‰; associated sulfates are heavier with $\delta^{34}S$ for barite (5 samples) ranging from +22.5 to +30.9 ‰. Limited fluid inclusion data for barite suggest a range of 120-130 °C for mineralization.

Salt dome cap rocks provide excellent physical and chemical traps for the localization of metals contained in formation waters. Metallic sulfides may be precipitated from metalliferous brines circulating in the permeable cap rocks as a result of interaction with reduced sulfur derived either by bacterial reduction of cap rock anhydrite in the presence of hydrocarbons or by externally derived reduced sulfur trapped in the salt dome environment.

STATUS OF GEOLOGIC AND HYDROLOGIC CHARACTERIZATION OF A POTENTIAL NUCLEAR WASTE REPOSITORY SITE IN BASALT

Nº 32350

PRICE, Susan M. and GEPHART, Roy E., Rockwell Hanford Operations, P. O. Box 800, Richland, WA 99352

The Basalt Waste Isolation Project (BWIP) is chartered with the responsibility of assessing the feasibility of using the Columbia River basalt beneath the U.S. Department of Energy's Hanford Site, south-central Washington, as a geologic medium for the disposal of nuclear waste. Within the BWIP, geohydrologic studies are focusing on repository site characterization, particularly those factors that might influence groundwater transport of radionuclides to the accessible environment.

Beneath the Hanford Site, the Columbia River basalt consists of at least 70 basalt flows extending to a depth of >3 km. Within the 180-km^2 central Cold Creek syncline, these flows appear to be nearly flat lying; at least four are thick (>40 m) and laterally continuous and are presently considered potential candidates for repository development. These flows lie 850 to 1,150 m below ground level within a 47-km^2 area currently considered to be the prime candidate site. Tectonic studies appear to indicate that the site area was deforming at a low average rate of strain in the Miocene and that this rate has continued into the late Cenozoic.

Available head and hydrologic data appear to indicate that groundwater within the deeper basalts generally moves laterally through zones of higher hydraulic conductivity (flow tops) and vertically through the fractured flow interiors. Hydraulic head gradients appear to be low (<10^{-3} m/m). Horizontal hydraulic conductivity values of 10^{-11} to 10^{-14} m/s have been measured within flow interiors; tests needed to obtain vertical hydraulic conductivity values are planned. An iterative approach involving numerical modeling and data collection and interpretation is being used to develop a preliminary geohydrologic conceptual model of the potential site and surrounding area.

DEFORMATION REGIMES AND DISLOCATION SUB-STRUCTURE IN SILICEOUS UNITS ALONG THE HELVETIC THRUST ZONE, EASTERN SWITZERLAND

Nº 13681

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Optical and transmission electron microscopy of samples from the siliceous units along the Helvetic thrust zone of eastern Switzerland show a systematic range of deformation regimes. Frontal locations show evidence of pressure solution but minor evidence of dislocation flow. Locations nearer the root zone show a transition to dislocation flow as the dominant deformation mechanism. On the basis of limited preliminary sampling, this transition appears to be near the anchizone/greenschist metamorphic boundary which cuts the internal structure of the thrust zone. Free dislocation densities range from 4.0×10^7 to 4.8×10^9 cm^{-2}, peaking in the middle of the thrust zone and decreasing toward the root zone. On the greenschist side of the boundary toward the root zone, recrystallization is nearly penetrative and grain size is relatively constant.

Although there are many uncertainties associated with the use of dislocation sub-structures as piezometers, it is interesting to note that the paleostresses derived from published differential stress/dislocation density relations and the overall changes in deformation style agree with previously published results for the carbonate units which make up the bulk of nappe pile. Recrystallized grain sizes imply significantly lower values for differential stress.

TEMPO AND MODE OF SPECIATION IN OLIGOCENE MAMMALS

Nº 30958

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Previous detailed studies of evolutionary patterns in fossil mammals have suffered from lack of geographic and temporal control, and from small, selective samples of the total fauna. Paleomagnetic studies of the Oligocene White River Group have given more precise stratigraphic resolution, and geographic control ranging over a transect from North Dakota to Colorado. We have surveyed the entire White River fauna, and examined the speciation patterns in all of the mammals that are reasonably abundant in the middle Oligocene (latest Chadronian-Orellan, about 32.7-30.7 Ma). These include the oreodonts Merycoidodon and Miniochoerus, the "deer" Leptomeryx, the camels Poebrotherium and Paratylopus, the horses Mesohippus and Miohippus, the rhinos Hyracodon and Subhyracodon, the rodents Ischyromys and Eumys, and the rabbit Palaeolagus. Most taxa are static through the interval, or show rapid morphological changes (such as inflation of auditory bullae in Merycoidodon, or change in premolar crest in Leptomeryx). These changes appear to take place in less than 100,000 years, based on estimation from known paleomagnetic datum levels. Only one possible example of gradualism occurs (dwarfing in Miniochoerus), and this size decrease can easily be interpreted as stepwise and punctuated. Thus, phyletic gradualism appears to be a rare phenomenon in Oligocene mammals. Most species are static for long periods of time, followed by rapid morphologic change, as predicted by the "punctuated equilibrium" model of speciation.

EASTERN NORTH AMERICAN JURASSIC BASALTS: AN INTER-BASIN PETROLOGIC MODEL

Nº 29478

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High-TiO_2 type magma of extremely uniform composition extruded onto the Culpeper, Newark, Hartford, and Fundy basins. This widespread vulcanism was probably approximately synchronous although the individual basins may not have been physically connected. These high-TiO_2 basalts chemically resemble the continental flood basalts within the African Karroo province and may be the product of similar extensional tectonic processes. The high degree of uniformity of the widely spaced high-TiO_2 basalts of eastern North America implies that they are not fractionation products of a more mafic parental magma and that they are not directly related to hot-spot activity. Compositional uniformity of the high-TiO_2 basalts extends into the phenocryst content, particularly the uniform composition of augites ($Ca_{.32}Mg_{.46}Fe_{.22}$) in the Culpeper, Newark, and Hartford basin basalts, although augites in the Fundy basalts are less uniform.

The high-TiO_2 basalts of the Culpeper, Newark and Hartford basins are each overlain by high-Fe_2O_3 type basalts of somewhat less uniform composition. The augite component of high-Fe_2O_3 basalt from each of these basins is relatively iron enriched ($Ca_{.33}Mg_{.36}Fe_{.31}$) with minor variation. The high-Fe_2O_3 basalt is probably derived from high-TiO_2 magma through fractionation processes that occurred in an upper mantle environment, perhaps at the base of an attenuated but still substantial thickness of crust.

The pyroxenes of the uppermost basalt units of the Culpeper, Newark, and Hartford basins are quite diverse. For example, within one sample of Millbrook basalt (Culpeper basin) augites range from $Ca_{.30}Mg_{.35}Fe_{.35}$ to $Ca_{.36}Mg_{.47}Fe_{.17}$ suggesting a complex set of reactions.

$^{87}SR/^{86}SR$ RATIOS OF CALCITES AND CAP ROCK OF HOCKLEY DOME, TEXAS: IMPLICATIONS FOR BRINE MOVEMENT RELATED TO SALT DOME MINERALIZATION AND CAP ROCK FORMATION

Nº 29407

Posey, H.H.,[1] Wessel, G.R.,[2] Fullagar, P.D.,[1] and Price, P.E.,[2]
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Oil field brines and minerals associated with Mississippi Valley-type deposits have similar 87Sr/86Sr ratios; these ratios are high compared to seawater ratios of their respective hosts and often surpass the highest mean values for the entire Phanerozoic (=0.7091). Sulfides within the cap rocks of the Hockley dome near Houston have been characterized as Mississippi Valley-type (Price, et al, in press). Ore textures suggest that sulfides formed during and after the limestone cap rock; e.g., marcasite pseudomorphs of gypsum are replaced by calcite, yet other sulfides replace that calcite.

To test the theory that Hockley sulfides formed from brines we examined Sr isotope ratios of cap rock limestones and vug-filling calcites. 87Sr/86Sr ratios of the cap rock limestones range from 0.7089 to 0.7100; early vug calcites = 0.7076-0.7097; late vug calcites = 0.7094-0.7104. Sr concentrations (69 to 158 ppm) are inversely proportional to the 87Sr/86Sr ratios. 87Sr/86Sr ratios of the Jurassic Louann evaporites, which are the source of Gulf Coast salt domes, are <0.7072 (Pushkar, et al, 1983), and fall within the range of Jurassic seawater.

It appears that a low Sr, high 87Sr/86Sr ratio material mixed with a high Sr, low ratio material (probably the Louann) to form both the cap rock and the vug-filling calcites. The high ratio source was probably a hot, basin-derived brine, or heated groundwater, or both. The Hockley cap rock Sr ratios are higher than the Louann evaporites and higher than the unmineralized Gulf Coast salt dome cap rocks thus far reported.

MODELING TUNNEL CATION DISPLACEMENTS IN HOLLANDITES USING STRUCTURE ENERGY CALCULATIONS

Nº 14080

POST, Jeffrey E.; and BURNHAM, Charles W., Dept. of Geological Sciences, Harvard University, Cambridge, MA 02138

Previously reported structure refinements of hollandites show that the tunnel cations exhibit anomalously high apparent thermal motion, and in many cases, are displaced away from special positions, 2a. We have used structure energy calculations to model the positional disorder and displacements for tunnel cations in $Ba(Ti,Al)_8O_{16}$ and hollandite. Cation-anion and anion-anion Modified Electron Gas short-range potentials were fit to Born-Mayer exponential relations, and Busing's WMIN program was used to obtain the minimum-energy structural configurations, using the positional parameters of the tunnel cations as variables. The Mn-O potential was derived by least squares fit to the pyrolusite structure.

Calculations were performed on a supercell corresponding to a tunnel-cation ordering repeat of two unit cells, as indicated by diffraction experiments. The calculated displacements of Ba in $Ba(Ti,Al)_8O_{16}$ ranged from 0.02 to 0.95 Å depending on the configuration of the Al in the octahedral framework. One model yielded a Ba displacement that matched exactly the observed value of 0.33 Å. This Al configuration was used for all subsequent calculations involving Ba and Sr tunnel cations. The calculated displacements for Ba and Sr in hollandite (with a smaller cell volume) are 0.14 and 0.63 Å, respectively, compared with observed values of 0 (large temperature factor) and 0.58 Å. K is at the special position, 2a, in both the calculated and observed structures. Our calculations confirm that the preferred site for Na is at or near the special position, 2b.

The positional disorder observed for tunnel cations in hollandites probably is caused by the occurrence of a variety of Al configurations in different unit cells. Our calculations show that several of these configurations yield nearly identical structural energies. Thus, for each tunnel cation type there will be a range of minimum energy positions.

THE SHULAPS THRUST AND ITS ROLE IN THE DEVELOPMENT OF A CHARACTERISTIC WESTERN CORDILLERAN MESOZOIC STRUCTURAL STYLE

Nº 19964

POTTER, C.J., Dept. of Geol. Sci., Cornell Univ., Ithaca, NY 14853

Exposures in the Shulaps Thrust zone, NW of Lillooet, B.C., provide a clear record of the genesis of features characteristic of telescoped Mesozoic ocean-margin terranes in the western Cordillera. These features include: 1) Oceanic mantle (Shulaps ultramafic complex) thrust upon marginal-basin supracrustal rocks (Bridge River complex); 2) A coherent greenschist/amphibolite facies tectonite body (Bridge River schists) produced by thrust-related metamorphism in the autochthon; 3) Thrust-related recumbent folding in these schists; 4) Late-stage imbrication of rocks of diverse parentage and deformational histories in a serpentinite-rich zone beneath the thrust. Early stages of thrusting produced penetrative ductile deformation and an inverted metamorphic gradient in the lower plate; transient synmetamorphic thermal gradients of 100-150°C/km beneath the thrust strongly suggest that the source of heat for metamorphism was in the allochthonous ultramafic slab. Pressures of metamorphism in the autochthon did not exceed 5 kb; maximum temperatures recorded in the structurally coherent part of the autochthon were 525-550°C. Thermal considerations and metamorphic evidence suggest that the Shulaps Thrust was rooted in a high-heat-flow setting. The thrust probably records the lateral collapse of an ocean-margin terrane such as a backarc basin. Late-stage mixing of rocks from diverse sedimentological settings beneath the thrust suggests that tens of km of displacement occurred.

Features related to the Shulaps Thrust support a model for accretionary imbrication and metamorphism of large volumes of marginal oceanic rocks which have not encountered a subduction zone.

PERIGLACIAL GEOMORPHOLOGY--REVIEW AND IMPLICATIONS FOR INSTRUCTION

Nº 27849

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Periglacial geomorphology has become more quantitative and process-oriented recently, following similar trends in other geomorphic fields. Periglacial processes have been important outside Pleistocene glacial borders and on Mars, and if we are to infer processes there, we must understand modern analogs. Recent large-scale construction for resource development in northern North America has stimulated and enhanced periglacial research and gives us practical reasons to understand a realm that most of us, especially students, seldom see.

Much but not all of the periglacial realm is underlain by permafrost, and physical processes dominate there, although chemical weathering is perhaps more important than the attention it has received would suggest. Water is ubiquitous on the earth's surface, but it takes on special significance in the periglacial world because it is unique among common materials in its property of volume change on freezing and thawing. In addition, contraction and expansion of permafrost at very low temperatures is important in some processes. The insulative effect of debris, soil, and vegetation over permafrost varies considerably, and small changes in thickness and properties allow differential thaw and produce distinctive landforms. Clear elucidation of the behavior of water and ice in cold environments should enhance student's appreciation of the complex origins of such features as pingos, gelifluction lobes, rock glaciers, thermokarst, and patterned ground. The consequences of ignorance of hazards to construction in periglacial environments are substantial.

THE ORIGIN OF MIOCENE DOLOMITES FROM FLORIDA CONSTRAINED THROUGH STABLE ISOTOPE STUDIES

Nº 23323

PRASAD, Sachindra and SWART, Peter K., Comparative Sedimentology Laboratory, R.S.M.A.S., University of Miami, Fisher Island Station, Miami Beach, FL 33139.

The Hawthorn Formation, the upper part of the thick, extensive Tertiary dolomitic sequence in Florida, consists of dolomite, phosphate, clays and siliciclastics. The dolomite is of particular interest because it is unlike mixing zone dolomites. Instead of a replacement habit, dolomite in the Hawthorn occurs as silt-size rhombs and forms a friable rock along with the other constituents. We have investigated the possibility that these dolomites contained isotopically negative carbon derived through the reduction of sulfate and concomitant release of phosphate from organic material. The removal of sulfate has previously been suggested to be associated with the dolomitization process. The carbon signature would show whether the dolomite was deposited at the same time as the phosphate, provide a fossil example of marine dolomites associated with young pelagic sediments from DSDP cores, and test the hypothesis that these dolomites formed from sulfate depleted pore waters.

Samples of dolomite were separated from co-occuring phosphate and calcite by hand picking and analyzed for carbon and oxygen isotope ratios by standard methods. Carbon isotopic compositions of the dolomite revealed that they were very 'normal', ranging between $\delta^{13}C$ = +1.6 to -1.4 °/oo (PDB) and similar to co-occuring calcites. This narrow range is in contrast to extremely variable $\delta^{13}C$ values shown for deep sea dolomites. Oxygen isotope ratios for the Hawthorn dolomite showed values of -1.5 to +3.65 °/oo (PDB). These data lead us to conclude that (1) dolomite formation was not syndepositional with the phosphate and;(2) sulfate elimination was probably not instrumental in the formation of these dolomite.