probably as extension fractures. In general, veins and stylolites formed at approximately the same time with local pore-fluid pressure acting as an important control. The scatter of principal strain orientations and a lack of consistent relations to bedding, shear zones, or fold geometry support an episode of minor, inhomogeneous strain.

THE HORSE ISLANDS GROUP:AN EXTENSION OF THE FLEUR DE LYS SUPERGROUP, NEWFOUNDLAND

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The lithological, structural, and metamorphic character of the Horse Islands is similar to parts of the nearby Fleur de Lys terrain of the western Burlington Peninsula, Newfoundland. A newly defined Horse Islands group of the Fleur de Lys Supergroup is proposed that has been informally subdivided into two lithologically distinct sequences of uncertain relative age.

The Hit or Miss Point sequence is a thick metasedimentary assemblage of regularly banded pebbly psammite and subordinate pelite that underlies the whole of the Western Island and part of the Eastern Island. It is in transitional contact with the lithologically more varied but predominantly pelitic assemblage of the Eastern Island sequence, which locally contains mafic schist zones of probable clastic origin. include

Both sequences are complexly deformed. Early phase structures/minor (and possibly large magnitude) tight to isoclinal steeply plunging folds and probable related schistosities. These are disrupted by later phase shear zones that are deformed by at least two generations of locally intense cleavages and related tight folds.

The geographical position of the islands with respect to similar sequences on the mainland of Newfoundland is considered a product of: either, an inherited feature of the irregular western margin to the developing Iapetus; or, post-depositional deformation. In the latter case post-Silurian SE-directed thrusting and, possibly, EW transcurrent faulting may be significant.

COMPOSITION AND LITHIC FACIES OF NEW ENGLAND UPPER TILL AND A POSSIBLE ORIGIN

CAGGIANO, Joseph A., Earth Sciences Group, Rockwell Hanford Operation, Richland, WA 99352.

Three lithic facies of sandy non-compact, clast-rich, subarkosic till were derived from three distinct rock types that are in contact along the Connecticut Valley Mesozoic border fault in west-central Massachusetts. The color and composition of these facies reflects assimilation of quartzo-feldspathic rocks of the Pelham Gneiss dome, quartz diorite and granodiorite of the Belchertown Intrusive Complex, and mud-rich arkosic fanglomerate of the Sugarloaf Arkose and Lower Longmeadow Sandstone. The mean grain size of the matrix of upper till in the Belchertown quadrangle is 70% sand, 22% silt and 8% clay. These three upper tills are time equivalent facies of the youngest Wisconsin drift and rest directly on source rock or on highly weathered, compact, sparsely stony, mud-rich fissile lower till.

The upper and lower till in the Belchertown quadrangle is texturally similar and a time equivalent of other upper and lower till of New England. Both tills are interpreted as basal till deposited by two different glaciers that flowed across similar bedrock terrane. The older glacier incorporated mud-rich saprolite producing a fine-grained till; the younger glacier assimilated bedrock or a thin mechanically weathered regolith. Upper till is interpreted as lodgment till because: (1) fresh upper till rests on weathered lower till; (2) it occurs in drumlins whose long axes are parallel to upland striae; (3) upper till rests directly on striated bedrock; and, (4) very fine sand and coarse silt are abundant in the matrix and are terminal grade sizes for quartz and feldspar.

DRUMLINS IN SOUTHWESTERN MAINE CONTAINING ABUNDANT STRATIFIED DRIFT

CALDWELL, Dabney W., Department of Geology, Boston University, Boston, Ma. 02215; HANSON, Lindley S., Earth Sciences Department, Salem State College, Salem, Ma. 01970; HOLLAND, William S., Department of Geology, Boston University, Boston, Ma. 02215

In Eliot and York, Maine, there is a group of twelve drumlins, seven of which have extensive exposures and six of these have abundant deposits of stratified drift. Although there are differences in the character of the washed drift in each drumlin, all deposits have the following features in common: 1) The largest deposits of stratified drift occur on the northwest (stoss) ends of the hills; 2) The bedding resembles the forset beds of deltas, with dips toward the north, northwest and northeast; and 3) Sediments range in size from silt and clay to boulders, and have little interbedded till. The stratified drift in each drumlin is molded into a streamlined form, indicating that an advance of ice either followed or accompanied the sand and gravel deposition. The drumlin till is not weathered more than the other surface till in the area and is thought to be of Wisconsin age.

There are many similarities between the stratified drift in the drumlins and that found in nearby late Wisconsin stratified end moraines in the area (e.g., Meriland Ridge). For this reason we feel the stratified drift deposits may represent moraines which were later incorporated in the drumlins by a readvance. If this interpretation is correct, the ice of the Kennebunk readvance is the likely candidate to have remolded the older moraines into the drumlins. The till portion of the drumlins may have been deposited as drumlins earlier, during the main Wisconsin ice advance and the stratified drift was then deposited on the drumlins. On the other hand, the till portion of the drumlins may have formed when the stratified drift was molded in the present drumlin form.

LANDWARD MIGRATION OF BARRIER ISLAND ENVIRONMENTS: DISCRIMINANT FUNCTION ANALYSIS OF SAND SIZE FREQUENCY DISTRIBUTIONS

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It has been demonstrated that there is a subsurface to surface landward shift in mean grain size of dune sands in the Plum Island-Castle Neck barrier island system in NE Massachusetts which is believed to be associated with shoreward dune field migration. Discriminant function analysis (DFA) was used to determine if there is also a shoreward migration of the surface microenvironments.

DFA is an objective statistical technique that can test a priori sample assignments on the basis of several variables considered simultaneously. Through a grouping of the surface environments into sediment response zones (beach-foredune, interdune, backdune), this multivariate technique can also be used to correlate past depositional conditions of subsurface sediments to response similarities of surface environments. These subsurface samples, taken at 1 m depth, represent a time-averaged "surface" of subrecent age.

248 sand samples, 124 surface and 124 subsurface, were collected and analyzed for grain size frequency distributions. Graphic statistics for the mean, median, standard deviation, skewness, and kurtosis represent the independent variables, while the three geomorphic zones represent the a priori microenvironments for DFA.

87% of the data variance was explained by the first discriminant function which is controlled by mean grain size. Frequency curves of the grouped scores for the surface and subsurface environments clearly show a westward (landward) shift through time. Maps of the discriminant scores also indicate this environmental shift shoreward.

GAHNITE-FRANKLINITE GEOTHERMOMETER AT THE STERLING HILL ZINC DEPOSIT, SUSSEX COUNTY, NEW JERSEY

CARVALHO*, Antone V. III and SCLAR, Charles B., Department of Geological Sciences, Lehigh University, Bethlehem, Pennsylvania 18015

The Sterling Hill zinc deposit is a folded and regionally metamorphosed stratiform oxide-silicate deposit enclosed in the Precambrian Franklin marble. Spinels composed of oriented exsolution intergrowths of gahnite (ideally $ZnAl_2O_4$) and franklinite (ideally $ZnFe_2O_4$) were collected at four locations in the Sterling Hill mine. Their bulk chemical composition and the composition of the individual phases which constitute the intergrowths were determined with the electron microprobe. The most aluminum-rich bulk chemical composition corresponding to that of a primary high-temperature homogeneous spinel is $Fr_{80}Ga_{20}$.

The miscibility gap in the system $ZnAl_2O_4$-$ZnFe_2O_4$ was determined experimentally by hydrothermal methods. Homogeneous synthetic spinels representing the full compositional range $ZnAl_2O_4$-$ZnFe_2O_4$ were prepared by dry reaction of high-purity oxides at 1300±80°C. Selected compositions of these synthetic spinels and equimolar mechanical mixtures of two synthetic spinels ($Fr_{90}Ga_{10}$ and $Fr_{10}Ga_{90}$) were sealed with water in separate platinum capsules and subjected to P_{H_2O} = 1Kb in the temperature range 700° to 900°C for periods up to 72 days. The oxygen fugacity was controlled by the hematite-magnetite buffer. Equilibrium was approached from two directions, namely, by exsolution of synthetic homogeneous spinels and by reaction of the spinels in the mechanical mixtures.

Integration of the electron microprobe analyses of the natural intergrowths with the experimentally determined miscibility gap indicates that the peak temperature attained during regional metamorphism at Sterling Hill was at least 760°C.

*Now at Sun Gas Company, Oklahoma City, Oklahoma 73112

EROSIONAL UNCONFORMITY ABOVE THE BAY OF ISLANDS OPHIOLITE COMPLEX AND THE PARA-ALLOCHTHONOUS NATURE OF OVERLYING SEDIMENTARY ROCKS

CASEY, John F. and KIDD, W.S.F., Department of Geological Sciences, State University of New York at Albany, Albany, NY 12222; PULASKI, Sylvana, University of Toronto, Toronto, Ontario, Canada

A previously unrecognized erosional unconformity overlies the Bay of Islands Ophiolite Complex on the North Arm Mountain Massif. Basal parts of the sedimentary section now overlying this unconformity have been fossil dated as Llanvirnian. The paleo-erosion surface has in places cut into crystalline rocks representative of deep stratigraphic levels within the ophiolite. This erosional surface also truncates originally low angle thrust faults which imbricate crystalline rocks, demonstrating that the ophiolite was eroded subsequent to its imbrication and initial transport. Other structural relationships show that these originally sub-horizontal thrust faults, the erosional surface, and overlying sediments were folded synchronously on a large scale. If as previous workers have suggested this folding pre-dated final emplacement of the allochthonous rocks onto the western margin, the sediments now overlying the Bay of Islands Ophiolite are at least in part para-allochthonous. Fossil age data is consistent with such and interpretation. Erosion of ophiolitic sheets during their transport westward onto the continental margin is also indicated by the occurrence of ophiolitic detritus within easterly derived flysch units and melange zones within the allochthon.

SYMPOSIUM: ADIRONDACK GEOLOGY I
Trinidad Room, 0800 hours

Bill Romey and Russell S. Jacoby, Presiding

Bill Romey: Introductory Remarks 0800

1 *Tibor Gasparik:* Geology of the Area between Elizabethtown and Mineville, Eastern Adirondacks 0805
2 *Lewis D. Ashwal,* Karl E. Seifert:* Rare Earth Element Evidence for Mafic Enriched Residual Liquids of the Massif-Type Anorthosite Suite, Adirondacks, N.Y. 0830
3 *Richard O. Sack:* Corona Reactions in Gabbroic-Ultramafic Rocks from the Eastern Adirondacks 0855
4 *James W. Granath,* N. Barstow:* Fold Growth and Transposition in Metasedimentary Rocks of the Southeastern Adirondacks 0920
5 *James McLelland,* Yngvar Isachsen:* Structural Synthesis of the Central and Southern Adirondacks, New York 0945

Recess 1010

6 *Brian B. Turner:* Polyphase Precambrian Deformation in the Newcomb Quadrangle, Central Adirondack Mountains, New York 1020
7 *Ennis P. Geraghty:* Nappe Formation, Fold-Interference Patterns, and Structural Evolution of the Blue Mountain Area, Central Adirondack Mountains, New York 1045
8 *E. J. Essene, J. W. Valley*:* High Pressure Akermanite in the Adirondacks 1110
9 *S. R. Bohlen, E. J. Essene*:* Distribution Coefficient Thermometry in Metamorphic Rocks—A Critical Appraisal 1135
10 *J. W. Valley, S. R. Bohlen*:* A Petrogenetic Grid for Adirondack Metamorphism 1200

SEMINAR: PALEOBIOLOGY OF SILURO-DEVONIAN REEFS IN NORTHEASTERN NORTH AMERICA
Suite F, 0800 hours

Robert M. Finks, Convener

The Seminar series was inaugurated last year by the Northeastern Section of the Paleontological Society as a means of bringing paleontologists up to date on recent work concerning a specific topic. The Seminars lie somewhere between a short course and a symposium. They are conceived of as a single unit, the atmosphere is informal, and discussion is encouraged. Although abstracts of the talks are presented in the abstract section of the Program and the order of speakers is given, specific times for each talk will not be listed, and participants are encouraged to attend the entire half-day session.

1 *Roger J. Cuffey,* Carolyn E. Davidheiser:* Paleoecologic Zonation within a Mid-Silurian (Rochester Shale) Patch Reef near Lock Haven, Central Pennsylvania
2 *Carlton E. Brett:* Pelmatozoan Echinoderms and Faunal Succession in Late Silurian (Wenlockian) Bioherms
3 *Pierre-André Bourque:* Evolution of a Silurian Reef Complex in the Gaspé Peninsula, Northern Appalachians
4 *Steven M. Warshauer,* Richard A. Smosna*:* Congruent Patch Reef Biofacies: A Comparison of the Mid-Appalachian Devonian with Modern Florida Analogs
5 *Peter E. Isaacson,* H. Allen Curran, Alexandra J. S. Smith:* Anatomy of Early Devonian Carbonate Buildups, Central New York
6 *Robert M. Finks,* Ira B. Lamster:* Differential Coral Growth in Onondaga Reefs
7 *L. A. Williams:* Physical and Biotic Controls in Thompsons Lake Reef (Middle Devonian, New York State) and Their Relevance to Community Succession Models
8 *Don L. Kissling,* Robert M. Coughlin:* Succession of Faunas and Frameworks in Middle Devonian Pinnacle Reefs of South-Central New York
9 *William A. Oliver, Jr.:* Devonian "Reefs" in New York: An Overview
10 *Colin W. Stearn,* Gary P. Smith:* Reef Development in the Blue Fiord Formation (Devonian) of Southwestern Ellesmere Island, Arctic Canada

An informal discussion of the Seminar papers will continue Thursday evening, March 1, 1900 to 2100 hours, in Suite E.

STRUCTURAL GEOLOGY AND TECTONICS I—NEWFOUNDLAND, NOVA SCOTIA, AND MAINE
Suite E, 0800 hours

Harold Williams and David R. Wones, Presiding

1 *K. Douglas Nelson:* Stratigraphy in the Badger Bay–Seal Bay Area of Western Notre Dame Bay, and Its Relationship to Ordovician Tectonics in Western Newfoundland 0800
2 *John T. Bursnall,* J. Hibbard:* The Horse Islands Group: An Extension of the Fleur de Lys Supergroup, Newfoundland 0820
3 *D. A. Knapp,* H. Williams:* Ophiolitic Rocks along the Baie Verte-Brompton Line at Grand Lake, Western Newfoundland 0840
4 *John F. Casey,* W.S.F. Kidd, Sylvana Pulaski:* Erosional Unconformity above the Bay of Islands Ophiolite Complex and the Para-Allochthonous Nature of Overlying Sedimentary Rocks 0900
5 *H. Scott Schillereff:* Relationship among Rock Units within and beneath the Humber Arm Allochthon at Fox Island River, West Newfoundland 0920
6 *H. Williams:* Relationships among Rock Groups at the Leading Edge of the Humber Arm Allochthon, Port au Port Peninsula, Newfoundland 0940
7 *J. Duncan Keppie:* Precambrian Tectonics of Nova Scotia 1000

*Speaker

PLEASE BRING THIS PROGRAM TO THE MEETING

abstracts with programs

Northeastern Section of The Geological Society of America 14th Annual Meeting

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