CANADIAN TECTONICS GROUP
11th ANNUAL MEETING

1991

11e RENCONTRE ANNUELLE
GROUPE CANADIEN DE TECTONIQUE

MAGOG, QUÉBEC

October 18-20 1991
18-20 Octobre 1991

ABSTRACTS, PROGRAM AND FIELD GUIDE

RÉSUMÉS, PROGRAMME ET LIVRET-GUIDE D'EXCURSION

Organized by/Organisé par:
GÉOTERAP, UNIVERSITÉ DU QUÉBEC À MONTRÉAL

Special collaboration/Collaboration spéciale:
MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES DU QUÉBEC

RENCONTRE ANNUELLE DU GROUPE DE TECTONIQUE CANADIEN
CANADIAN TECTONICS GROUP ANNUAL MEETING
Magog, (Québec), 18-20 Octobre, 1991

PROGRAMME

VENDREDI le 18 Octobre/FRIDAY, October 18th

. . . . . Arrivée à l'Auberge de l'Etoile, Magog ■ Arrival at l'Auberge de l'Etoile, Magog.

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@19:30 *SOUPER* à la carte, *Bar-payant* ■ *DINNER* à la carte, *Cash-Bar*.

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AFFICHES/POSTERS Les affiches devraient être exposées le plus tôt possible afin de permettre un maximum de visualisation. Il y aura du temps alloué durant les pauses-café ainsi qu'à la fin de la journée samedi ■
Posters should be set up as soon as possible to allow maximum time of viewing. There will be time during breaks and at the end of the afternoon on saturday.

21:00 ** Réunion dans la Salle Panorama (2ème étage). Introduction aux affiches. Courtes présentations orales (max. 5 min./chacune) des affiches ■
Convene in the Panorama Room (2nd floor). Introduction to the posters. Oral presentations of the posters (max. 5 min./each).

P.S. Le BAR vous offre une consommation gratuite sur présentation du coupon ci-inclus. A votre santé pour les autres! ■
A free drink is on the house upon presentation of the coupon included herein. Best of luck for the other one(s)!

SAMEDI le 19 Octobre/SATURDAY, October 19th

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7:00 - 8:00 am *Brunch*

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SESSIONS PLENIERES/TECHNICAL SESSIONS

8:15 - 10:00 Président/Chairman - Dr. Larry Lane

8:15 - 8:30	Frank Fueten*, P.-Yves Robin	FINITE ELEMENT MODELLING OF THE PROPAGATION OF A PRESSURE SOLUTION CLEAVAGE SEAM
8:35 - 8:50	Jacob A. de Roo	LAMINATED VEINS AND HYDROTHERMAL BRECCIA AS MARKERS OF THRUST MOTION (RHENISH MASSIF, GERMANY)
8:55 - 9:10	P.-Yves Robin*, Alexander Cruden	STRAIN FABRIC PATTERNS IN IDEALLY DUCTILE TRANSPRESSIVE ZONES
9:15 - 9:30	Lynn L. Pryer*, P.-Yves Robin	A MODEL FOR ALBITE FLAME GROWTH

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Pause-café ■ *Coffee Break*/Affiches ■ Posters

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10:30 - 11:30: Président/Chairman - Dr. Laurel Goodwin

10:30 - 10:45	Paula MacKinnon*, P.-Yves Robin	SUPERPLASTICITY IN STRAIGHT GNEISSES
10:50 - 11:05	Simon Hanmer*, Chris Kopf Mark Darrach Randy Parrish	COMPLEX KINEMATICS, STRAIN RATE DISTRIBUTION AND MAGMA EMPLACEMENT IN AN ARCHEAN SEGMENT OF THE SNOWBIRD TECTONIC ZONE, N. SASKATCHEWAN
11:10 - 11:25	Chris Beaumont Smith*, Paul F. Williams, M. B. Lambert	STRUCTURAL GEOLOGY OF THE BACK RIVER VOLCANIC COMPLEX, NORTHWEST TERRITORIES

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11:30 - 12:45 *Buffet*

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13:00 - 17:00 Excursion de la zone de Dunnage en bordure de la zone Brompton-Baie Verte ■ Field trip in the Dunnage zone straddling the Brompton-Baie Verte zone.
Départ de l'entrée principale de l'Auberge ■ Leaving from the main entrance

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20:00 *SOUPER CONFERENCE ■ CONFERENCE DINNER*

21:00 Réunion de travail de la division de Géologie Structurale et Tectonique de l'Association Géologique du Canada ■ Meeting of the Structural and Tectonics Division of the Geological Association of Canada

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22:00 . . . .

POSTERS

Paul Budkewitsh, and Andrew Hynes	A WESTERN SOURCE FOR THE NASTAPOKA BASALTS (CIRCUM-SUPERIOR BELT) DETERMINED FROM MAGNETIC SUSCEPTIBILITY FABRICS
Louise Corriveau, and Vincent Jourdain	TERRANE CHARACTERIZATION IN THE CENTRAL METASEDIMENTARY BELT OF QUEBEC
Jun Cowan, and Fried Schwerdtner	DEFORMATION OF THE EASTERN SUDBURY STRUCTURE
Lisel Currie	A ONE KILOMETER-WIDE TECTONIC MELANGE: HAVE YOU SEEN ANYTHING LIKE THIS BEFORE?
Stéphane Faure, and Alain Tremblay	THEORETICAL ANALYSIS OF SLICKENFIBERS IN SHEARED SERPENTINITE
Jean Goutier	ANALYSE STRUCTURALE PRELIMINAIRE DES UNITES BORDANT LA FAILLE DE PORCUPINE-DESTOR DANS LE NORD-OUEST QUEBECOIS
Shaocheng Ji, Matthew Salisbury, and Simon Hanmer	(1) MEASURED AND CALCULATED P-WAVE VELOCITIES OF HIGH GRADE MYLONITES FROM THE SNOWBIRD TECTONIC ZONE (CANADA): IMPLICATIONS FOR THE SEISMIC ANISOTROPY AND REFLECTIVITY OF LOWER CRUSTAL FAULT ZONES

	(2) MEASURED AND CALCULATED S-WAVE VELOCITIES AND SHEAR-WAVE SPLITTING IN HIGH GRADE MYLONITES: IMPLICATIONS FOR KINEMATICAL ANALYSIS IN THE LOWER CRUST

Donna Kirkwood, and Benoit Dubé	STRUCTURAL CONTROLS AND TIMING OF MINERALISATION IN THE SILL-HOSTED STOG'ER TIGHT GOLD DEPOSIT, BAIE VERTE PENINSULA, NORTHWESTERN NEWFOUNDLAND.

Sylvain Lacroix, and Jacques Landry	ANALYSE STRUCTURALE D'UN TRONCON DE LA FAILLE PORCUPINE-DESTOR (FPD), ABITIBI-SUD, QUÉBEC

James Dietrich, and Larry Lane	TERTIARY STRUCTURAL EVOLUTION OF THE BEAUFORT-MACKENZIE BASIN

Patrick Launeau	SHAPE PREFERRED ORIENTATION OF MAGMATIC GRANITE SUB-FABRICS USING IMAGE ANALYSIS

Greg Lynch, and Christian Tremblay	IMBRICATE THRUSTING, REVERSE FAULTING, AND LATE EXTENSION IN THE ACADIAN OROGEN OF THE CENTRAL CAPE BRETON HIGHLANDS, NOVA SCOTIA

Michel Malo	STRUCTURALLY-CONTROLLED MINERALIZATION ALONG THE GRAND PABOS FAULT, SOUTHERN GASPE PENINSULA, QUEBEC APPALACHIANS: A PRELIMINARY STUDY

James Moorhead, Réjean Girard, et Tyson Birckett	PROBLÉMATIQUE DU FRONT DU GRENVILLE A L'EST DE L'AXE SENNETERRE-LOUVICOURT

Léopold Nadeau	BREAKBACK THRUSTING AND ASSOCIATED METAMORPHISM AT MID- TO DEEP CRUST, SOUTHWESTERN CENTRAL GNEISS BELT, GRENVILLE OROGEN

Greg Stott	A CLADISTIC ANALYSIS OF THE CONSTRUCTION OF THE SUPERIOR PROVINCE: A REPRESENTATION OF ONE HYPOTHESIS

Frank Schrader, Fried Schwerdtner	TECTONIC TRANSPORT ANALYSES IN THE EUREKA SOUND FOLD BELT, ARCTIC CANADA

DIMANCHE le 20 Octobre/SUNDAY, October 20th

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7:00 - 8:20 am *Brunch*

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SESSIONS PLENIERES/TECHNICAL SESSIONS

8:30 - 10:00: Président/Chairman - Dr. Alain Tremblay

8:30 - 8:45	Joseph C. White*, C. A. Brown, S.C. Leitch	TRANSIENT DISCONTINUITIES REVISITED - FRICTIONAL MELTS AND MYLONITES
8:55 - 9:10	Fried Schwerdtner	CONTRACTION FOLDS AS SHEAR SENSE INDICATORS
9:20 - 9:35	Paul F. Williams*, R. H. Vernon	TRANSPRESSIVE DEFORMATION AT BROKEN HILL, AUSTRALIA AND THE PROBLEM OF VERTICAL LINEATIONS IN TRANSCURRENT SHEAR ZONES
9:40 - 9:55	Shoufa Lin*, Paul F. Williams	THE GEOMETRICAL RELATIONSHIP BETWEEN THE STRETCHING LINEATION AND THE MOVEMENT DIRECTION OF THE SHEAR ZONE

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Pause-café ■ *Coffee break*/Affiches ■ Posters

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10:15 - 11:50: Président/Chairman - Dr. Louise Corriveau

10:15 - 10:30	David Halwas, Philip Simony*	THE KINNAIRD PLUTON: A MULTIPLE GRANITIC SHEET
10:40 - 10:55	Réjean Girard	RELATIONS ENTRE LE MOUVEMENT ASSOCIÉ AU CISAILLEMENT DE LA RIVIERE GEORGE ET LA DÉPOSITION DU GROUPE DE LA HUTTE SAUVAGE, DANS L'ARRIÈRE-PAYS DE LA FOSSE DU LABRADOR.
11:05 - 11:20	Daniel Lebel	TECTONOSTRATIGRAPHIC SETTING OF THE HUMBER ZONE IN THE MONTMAGNY-BELLECHASSE AREA

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12:00 - 13:00 Si le climat le permet nous irons grignoter notre *Lunch* sur le sommet du Mont Giroux d'où l'on a une vue panoramique de la région de Magog et l'extension latérale de la zone Brompton-Baie Verte ■ If the wheather permits we will eat our *Lunch* on top of Mount Giroux for a panoramic view of the Magog region. We will also observe the lateral extension of the Brompton-Baie Verte zone.

Rassemblement des participants avec leurs bagages devant l'entrée principale de l'Auberge ■ Everyone should meet at the main entrance with their luggage ready to go.

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13:00 - 17:00 Excursion dans la zone de Humber ■ Field Trip in the Humber zone

Les participants sont assurés d'un transport à l'aéroport de Dorval en temps pour leur départ ■ Participants will be delivered to the Dorval Airport one hour prior to their departure.

MERCI A TOUS DE VOTRE COLLABORATION ET VOTRE PARTICIPATION.

MANY THANKS TO ALL FOR YOUR COLLABORATION AND PARTICIPATION.

Le comité organisateur,

Marc Bardoux,

Normand Goulet,

Robert Marquis.

EARLY SE-DIRECTED BACKFOLDING AND A LACK OF ORDOVICIAN CALC-ALKALINE MAGMATISM: AN INDICATION OF TACONIC TRANSPRESSIVE REGIMES ALONG THE NORTHERN SEGMENT OF THE QUEBEC REENTRANT?

Bardoux, M., Département des Sciences de la Terre -GEOTERAP-, Université du Québec à Montréal; ***Marquis, R.***, Ministère de l'Energie et des Ressources du Québec, Sherbrooke; ***Gauthier, M.***, Département des Sciences de la Terre -GEOTERAP-, Université du Québec à Montréal; ***Brodeur, E.***, Département des Sciences de la Terre, Université du Québec à Montréal; ***Castonguay, S.***, Queen's University, Kingston, Ontario.

The Saint-Ferdinand de Halifax region, located west of Thetford Mines, comprises three Early Paleozoic sequences. In younging order there are: (1) metababslats of the Tibbit Hill Formation (ca. 560Ma); (2) coarse clastics and dolomitic mounds of the Pinnacle Formation and (3) purple and green metapelites of the Armagh? Group. The coarse clastic sequence is conformably overlying the Tibbit Hill Formation. It presents rapid facies changes but generally consists of pure quartzite. This is interpreted as a near shore deposit. Metapelites represent a deeper water assemblage. Their contact with the underlying quartzites and dolomites is generally sheared but they may be in continuity with the clastics indicating that the basins were foundering rapidly.

The region straddles the northern boundary of the Quebec Reentrant. It was submitted to at least three phases of deformation culminating in a broad anticlinorium. The S_1 foliation is considered to be Taconic and is axial planar to tight isoclinal F_1 folds. These structures are systematically reclined with axial planes dipping 60° to the northwest and hinge lines plunging less than 25° to the southwest. Limbs of these structures are systematically sheared to mylonites. Kinematic indicators (C, S, C' surfaces, asymmetric porphyroclasts and asymmetric folds) are consistently suggesting a top to the southeast sense of shear. This motion is toward the Notre-Dame anticlinorium (a complex ?melange of stratigraphic sequences similar to the Saint-Ferdinand region interleaved with serpentinites) and toward the Thetford Mines Ophiolite.

Since accretionary complexes generally develop faults with opposite convergence to the subducting polarity, the sense of shearing of early folds may indicate that subduction during the Taconic orogeny was to the NORTHWEST. However, owing to the absence of Ordovicina calc-alcaline arc magmatism west of the Thetford Mines Ophiolite, and considering the northwest vergence of Acadian folds east of the Ophiolite, it has been argued that subduction must have been to the southeast.

Alternatively, the geometry of the first generation folds anf faults in the Saint-Ferdinand region could imply an oblique transpressive regime. This interpretation is consistent with the lack of high grade metamorphic domains in this part of the hinterland of the Quebec Reentrant. It also consistent with the hypothesis that the BBVL was the locus of strike-slip motion. If the Quebec Reentrant was the locus of transpressive regimes during Taconic and Acadian orogenies, this precludes reconstructing balanced cross sections. This further suggests that spreading ridges of Iapetus in this part of the Appalachians were impinging obliquely to the paleocontinental shelf in a configuration similar to that of the Red Sea spreading system.

A WESTERN SOURCE FOR THE NASTAPOKA BASALTS (CIRCUM-SUPERIOR BELT) DETERMINED FROM MAGNETIC SUSCEPTIBILITY FABRICS

Paul Budkewitsh and **Andrew Hynes**, Department of Geological Sciences, McGill University, 3450 University Street, Montréal P.Q. H3A 2A7.

The Nastapoka basalts of the eastern Hudson Bay coast are part of a thin Proterozoic cover that unconformably overlies Archean gneisses. The entire succession lies within the Nastapoka Arc and is gently tilted seaward, exposing sections of basalt flows along some 300 km of coastline. This transect represents a random section through a formerly extensive flood-basalt whose source area is uncertain.

Flow-directions in basalt flows are best estimated from primary structures, however good field examples are infrequently exposed. In igneous rocks, the anisotropy of magnetic susceptibility (AMS) measured from orientated samples is a useful petrofabic tool that has often been used to indicate flow-directions. In this study, primary structures and AMS fabrics are correlative: a subhorizontal magnetic foliation (K_{max} and K_{int}) is essentially subparallel to the plane of the basalt sheet. Good agreement exists between the trends of the maximum susceptibility axes (K_{max}) and the azimuths of inclined pipe vesicles and spiracles or aligned plagioclase phenocrysts.

Overall, Nastapoka basalts flowed east-northeast from a western volcanic source. No relationship is observed between the present arcuate coastline and the flow directions in the basalt flows. These results suggest the existence of a regional (linear?) east-dipping paleoslope, rather than a circular thermal dome that later cooled and subsided to produce the Nastapoka Arc.

TERRANE CHARACTERIZATION IN THE CENTRAL METASEDIMENTARY BELT OF QUEBEC

Louise Corriveau et Vincent Jourdain, Centre Géoscientifique de Québec.

A geoscientific study combining an igneous petrological approach with geological mapping has been undertaken to investigate the accretionary history of the Central Metasedimentary Belt (CMB) in the Grenville Province of Québec. Terrane characterization is based on contrasts in igneous suites which predate amalgamation. The CMB is separated from the Morin terrane to the east by the Labelle shear zone. Massif-type anorthosite and mangerite typical of the Morin terrane have previously been reported in the CMB. This work establishes that the anorthositic rocks in the CMB occur in vertically layered mafic intrusions, and are not part of anorthosite massifs. Massif-type anorthosites occur as slivers in the Labelle shear zone and may mark the limit of the Morin terrane. Mafic intrusions occur throughout the CMB and are spatially associated with elongated porphyritic monzonite bodies (none of which are mangeritic) and net-veined dykes. Porphyritic monzonite also occurs in the Morin terrane but in association with mangerite and charnockite bodies. A late-tectonic, 1089-1076 Ma, K-rich alkaline plutonic suite occurs in part of the CMB but not in the Morin terrane. The plutonic rock assemblages in the CMB appear to be distinct from those of the Morin terrane, however magmatism may have occurred simultaneously in the two terranes. Within the southern part of the CMB, a U-shaped domain is devoid of 1089-1076 Ma K-rich alkaline plutons and was proposed to be a northern extension of the Frontenac terrane of Ontario. The domain is shown to consist predominantly of quartzite, impure quartzite and metapelite with minor marble. The main plutonic units are the porphyritic monzonite bodies and the mafic layered intrusions. In addition, this domain contains a late-tectonic pluton of noritic gabbro and syenite and dykes of hornblende-bearing mafic and ultramafic lamprophyres. The western and eastern limits of this domain coincide with a sharp change in supracrustal sequences where marble becomes abundant. No lithological nor structural discontinuities were observed in the supracrustal sequence at the northern limit of the domain. A north-trending high strain zone occurs within the quartzite-rich supracrustal rocks near the eastern limit of this domain. These findings raise a series of questions; what is the significance and extent of the high strain zone? What is the extent of the quartzite-rich supracrustal sequence? What is the magmatic affinity of the hornblende-bearing lamprophyre? Are the vertically layered mafic intrusion restricted to the southern domain? Is this domain an extension of the Frontenac terrane?

DEFORMATION OF THE EASTERN SUDBURY STRUCTURE

E. J. Cowan and **W. M. Schwerdtner**, Department of Geology, University of Toronto, Toronto, Ontario, Canada M5S 3B1.

Recent study suggests that the South Range of the 1850 Ma. Sudbury Structure underwent northwesterly-directed non-coaxial reverse shearing, while its sedimentary core was foreshortened in the NW-SE direction (Shanks & Schwerdtner 1991, CJES 28, 411-430). In the East and North Ranges of the Sudbury Structure, however, the timing of the Sudbury Igneous Complex deformation relative to its magmatic emplacement is not clearly known. Although most of the deformational features (L-S & C-S fabrics) seen in the South Range are solid-state features indicating post-emplacement deformation, such features are conspicuously absent in the East and North Ranges of the Sudbury Igneous Complex, yet the map pattern of the Sudbury Igneous Complex suggests fold-like geometry indicating the the Igneous Complex must have strained either during or after its magmatic emplacement. Field mapping has indicated that the Sudbury Igneous complex is virtually unstrained in the East and North Ranges, while the South Range shows well developed L-S fabrics. The sedimentary core is weakly strained but contains a prominent steeply dipping penetrative cleavage. In the northeastern fold-like "lobe" of the Sudbury Structure, a well developed axial planar cleavage in the sedimentary core gives way along strike to an igneous foliation having the same axial planar orientation. Preliminary investigation of magnetic fabrics of the Sudbury Igneous Complex confirms the orientation of the igneous foliation observed in the field. The magnetic fabric of the Igneous Complex is concordant to the schistosity trajectories of the sedimentary core in the northeastern "lobe" and the East Range, while in the southeastern "lobe" the magnetic fabric trajectory appears to be concordant to the boundary trace of the Sudbury Igneous Complex. It appears that the folding of the Sudbury Igneous Complex occurred during its magmatic emplacement, or at least prior to its consolidation. In contrast to this the solid-state fabrics observed in the South Range were developed after the cooling of the Sudbury Igneous Complex, suggesting that large-scale shearing outlasted the folding. Further work is needed to ascertain the complete pattern of the magnetic foliation trajectories within the eastern Sudbury Igneous Complex.

A ONE KILOMETER-WIDE TECTONIC MELANGE: HAVE YOU SEEN ANYTHING LIKE THIS BEFORE?

Lisel Currie, Ottawa-Carleton Geoscience Centre, Ottawa, Ontario.

The Willison Creek shear zone (WCSZ) is a 1 km wide tectonic melange that can be traced for at least 15 km in the Coast Mountains of northwestern British Columbia. It is bounded by two faults that dip about 45o to the southwest. Between the faults is a chaotic melange of blocks (1 to 200 m3) of marble, schistose rock, and quartzite that are juxtaposed by brittle faults which have no preferred orientation. Fabrics in the blocks provide evidence for at least two phases of ductile deformation that pre-date brittle movement on the faults, and therefore the melange cannot be a primary structure. Undeformed plutonic rocks (hornblende diorite, quartz monzonite, and pegmatite) intrude metamorphic rocks within the shear zone, but are also offset by brittle faults within the shear zone.

The WCSZ is best exposed in the north, where the hanging wall and footwall contain biotite schist, muscovite schist, amphibolite, quartzite and marble of the Florence Range metamorphic suite. Relative to the hanging wall, the footwall contains less amphibolite, less marble, and quartzites are fine-grained and graphitic, rather than medium-grained and mature. Rocks within the shear zone generally resemble those of the hanging wall and footwall, but some lithologies found within the shear zone have not been observed elsewhere. To the south, the WCSZ juxtaposes foliated Middle Jurassic hornblende granodiorite of the Tagish Lake suite (Mt. Caplice orthogneiss) against Florence Range metamorphic suite rocks. Consequently movement on the WCSZ must have occurred after Middle Jurassic time.

The significance, sense of shear, and cause of movement on the WCSZ are not presently understood. However, the WCSZ is well exposed and therefore provides an excellent opportunity to contemplate the possible physical conditions that resulted in the formation of a 1 km wide tectonic melange

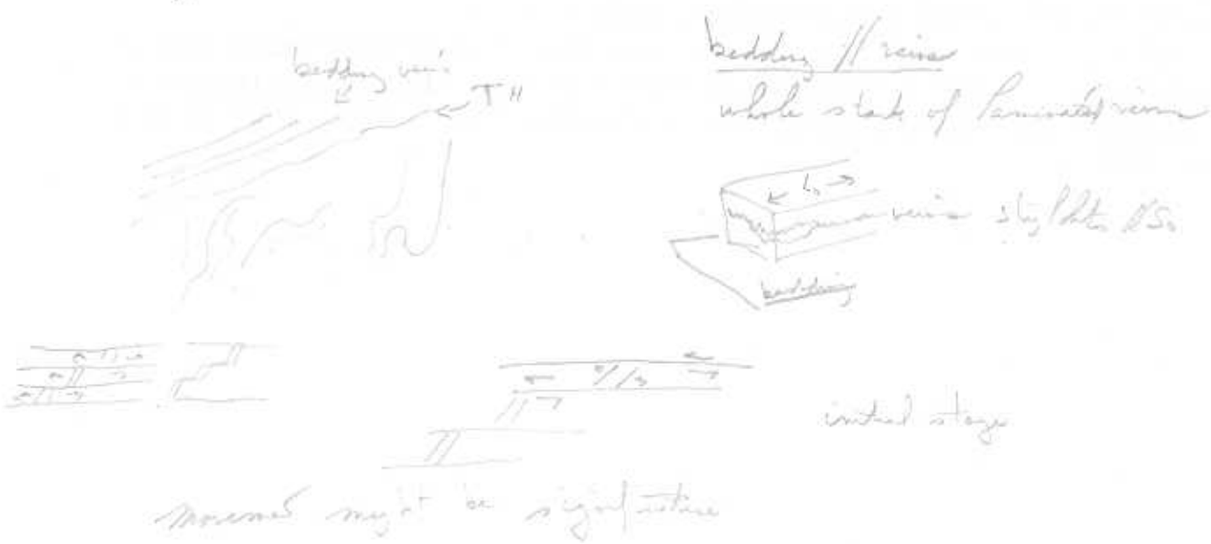
LAMINATED VEINS AND HYDROTHERMAL BRECCIA AS MARKERS OF THRUST MOTION (RHENISH MASSIF, GERMANY)

Jacob A. de Roo, INRS - Georessources, 2700 rue Einstein, Sainte-Foy, Québec, G1V 4C7

The Rhenish Massif in Germany is an Upper Palaeozoic slate belt in the foreland of the Hercynian fold and thrust system. The thrusts transported northwestward and consist of "*ramps*" (discordant) and "*flats*" (parallel to bedding (S_o)). The flats are marked by bedding-parallel veins of quartz and carbonate. Both shear veins and extensional veins are distinguished on the basis of fibrous crack-seal microstructures.

Most **shear veins** grew by incremental pull-apart between en echelon slip surfaces (in S_o), the overlap of which produced a vein stack. The stacks have a "*slickensides*" lineation (L_o) resulting from a combination of slip, fibre growth and dissolution ("*pressure solution slip*"). The attitude of L_o relative to fold axes and the asymmetry of vein microstructures are consistent with vein emplacement and stacking during the Hercynian thrusting. Finite thrust displacement (10m $< x >$ 1000m?) across the vein stacks is based on the total length (in L_o) of component veins. The veins illustrate the "*dislocation-style*" motion of thrust sheets.

The shear veins include coeval sheets of **vein-hosted breccia**. The breccia contains angular fragments of (mylonitized) veins and slate. The orientation of S_o and S_1 in the breccia varies randomly per fragment, indicating random fragment rotation. Unencumbered spin of country rock debris implies rock expansion, possibly by rapid pull-apart events ("*slip*") during "*stick-slip*" thrusting.



TERTIARY STRUCTURAL EVOLUTION OF THE BEAUFORT-MACKENZIE BASIN

James R. Dietrich, and **Larry S. Lane,** Institute of Sedimentary and Petroleum Geology, Geological Survey of Canada, 3303-33 rd St., NW, Calgary Alberta, T2L 2A7

Beaufort-Mackenzie Basin sediments of Late Jurassic to Tertiary age were shortened in an arcuate trend during Tertiary Brookian orogenesis. A major pulse of Early Eocene folding and thrust faulting affected much of the central and western Beaufort-Mackenzie basin. Concurrent longitudinal normal faulting occurred on land, in the western Beaufort and near the southeast basin margin (Taglu fault zone). A second major orogenic pulse of Miocene age caused deformation concentrated in the distal part of the deformed belt, in Demarcation subbasin-Herschel high, and between the Taglu and Tarsiut-Amauligak fault zones. A large area of southwestern Beaufort-Mackenzie basin was largely undeformed by this pulse but was transported basinward on a décollement zone(s). Seismic images of many offshore structures show obvious asymmetry, other structures are clearly detached. Onshore, important décollement horizons occur at several stratigraphic levels. Concurrent extension occurred principally in the Tarsiut-Amauligak fault zone.

In general, the deformation shows a foreland-younging trend, away from the craton. Temporal and spatial variations in tectonic shortening require secondary accommodation by right-lateral transcurrent faulting, concentrated along the southeast basin margin and in a zone trending northeastward from near Kay Point through the Tarsiut area. Although minor at the basin scale, transcurrent faulting may be locally very significant at the scale of individual prospects.

THEORETICAL ANALYSIS OF SLICKENFIBERS IN SHEARED SERPENTINITE

Faure, Stéphane, and **Tremblay, Alain,** Institut national de la recherche scientifique - Géoressources, C.P. 7500, Sainte-Foy, (Québec), G1V 4C7

In ophiolite, incohesive serpentinites are the most commun product of deformed ultramafic rocks. The movement along associated anastomosing shear zones is characterized by successive incremental strain recorded along boundaries of rigid blocks (peridotite). Planes forming the surface of the blocks have a large distribution of orientations and contains linear, curved or crusscuting slickenfibers. These brittle structures are used as a tool to determine the orientation of maximum principal stress tensors ($\sigma 1, \sigma 2, \sigma 3$). We present an empirical model on the behavior of striated fault planes that would developed in serpentinites during pure shear and simple shear.

The reference volume is an isometric polyhedron submitted to a horizontal and non-rotationnal constraint system where $\sigma 1 > \sigma 2\ \sigma 3$. Slickenfibers on each fault planes will be linear if the deformation occurs during a pure shear regime, and curved if it occurs during simple shear regime.

In a pure shear deformational regime, structures ranging from thrusts to strike-slip faults will be theoretically developed depending on the attitude of the fault plane with the orientation of the maximum stress tensor $\sigma 1$. Thrusts are located mostly along sub-horizontal surfaces (sub-parallel to $\sigma 1$), and strike-slip faults seem to be predominant along steeply-dipping planes perpendicular to the horizontal.

In a simple shear regime, the trace of shear strain on the fault plane is curved, because the reference volume turns around a rotation axe wich is parallel to fault zone boundaries. Fault planes containing the rotation axis will show linear slickenfibers, all other planes will show curved slickenfibers with various radii of curvature. During a pure rotation, the first increments of deformation associated with a single curved trajectory are characterized by normal faulting. Later increments are associated with strike-slip movement, and finally with reverse faulting. The youngest to the latest movement deduced from curved slickenfibers give the sense of axial spin of the associated plane. This spin would be the opposite to the rotation wich characterizes the fault zone boundary. Crusscutting slickenfibers may developed during a discontinuous rotation of an external principal strain in pure shear, or during discontinuous rotation of the volume reference in simple shear.

A compute program based on the Angelier method wich will analyse paleostress evolution from both theoritical and observed striated faults is the next step of this study. The main problems with the numeric method are related to the treatment from simple shear deformation data. The favored approach is to use a known $\sigma 1$ in order to determined on each fault plane of the reference polyhedron the sheared strain vector. In the future, a comparison between theoritical models and natural examples will hopefully provide a key to a better understanding of complex fault zones such as the Brompton - Baie-Verte Line.

FINITE ELEMENT MODELLING OF THE PROPAGATION OF A PRESSURE SOLUTION CLEAVAGE SEAM

Frank Fueten* and Pierre-Yves F. Robin**
* Brock University, St. Catharines, Ontario, Canada, L2S 3A1
** Tectonic Studies Group, Geological Sciences, Erindale Campus, University of Toronto, Mississauga, Ontario, Canada, L5L 1C6

The propagation of a cleavage seam is modelled by a 2-D finite element technique, as the extension of Fletcher and Pollard's (1981) elastic "anticrack" to a composition-dependent viscous rheology. The viscous solution is obtained by repeated solutions of the force equilibrium equations at successive time steps, with the viscosity of each element varying as a function of its strain history. A dependence of rheology on composition is assumed, following a model of Robin (1979): the rock is modelled as a 'quartz'-'mica' mixture in which deformation proceeds by diffusion of 'silica'. The viscosity of an element depends on its proportion of 'quartz', varying from a minimum for intermediate 'quartz'-'mica' mixtures to higher values for either pure 'quartz' or pure 'micas'. As a result of its incremental strain, an element either loses or gains 'quartz' (i.e. volume), and therefore changes its viscosity for the next strain increment. The system can be either open ('silica' escapes the system; all individual elements lose volume) or closed (individual elements may gain or lose volume but the total volume of the system is preserved).

At the start of a run, a nucleus of a cleavage seam is introduced as a thin layer of elements with a lower viscosity (corresponding to a higher 'mica' content) than the rest of the rock. The stress concentration at the tip of the seam leads to a weakening of the elements in front of it through loss of 'quartz'; this results in crack propagation, for both open and closed systems. All other parameters being equal, the 'speed' of propagation is greater for open systems than for closed ones.

RELATIONS ENTRE LE MOUVEMENT ASSOCIÉ AU CISAILLEMENT DE LA RIVIERE GEORGE ET LA DÉPOSITION DU GROUPE DE LA HUTTE SAUVAGE, DANS L'ARRIÈRE-PAYS DE LA FOSSE DU LABRADOR.

Réjean Girard, Université du Québec à Chicoutimi

L'arrière-pays des orogènes protérozoïques inférieurs du Nouveau-Québec et de Torngat (nord-est du Québec et nord du Labrador) se compose de gneiss polycycliques affectés par la déformation hudsonienne. Le trait structural dominant s'y compose de grands cisaillements catazonaux montrant un mouvement transcourrant dextre (Nouveau-Québec) ou senestre (Torngat). Le cisaillement de la rivière George (CRG), au centre du terrain interorogénique, montre une histoire tectonométamorphique complexe et des mouvements composites. Le Groupe de la Hutte Sauvage (GHS) est un empilement siliciclastique tardif situé adjacent au CRG. Le Groupe n'est pas affecté par la mylonitisation due au cisaillement, mais est toutefois affecté d'un raccourcissement est-ouest de 20 %. Des galets provenant du Batholithe de De Pas y limitent l'âge de la sédimentation à 1.84 Ga. Une analyse de faciès sédimentaire révèle que les sédiments ont une provenance locale et qu'ils se sont déposés en bordure d'une faille affectée d'un mouvement normal en ciseau à sa bordure ouest. Cette faille coïnciderait avec le CRG et y représenterait ainsi un mouvement tardif. En utilisant le GHS comme marqueur temporel, les mouvements suivants peuvent être mis en lumière pour le CRG: **A)** latéral dextre en régime catazonal selon le patron régional; **B)** normal en ciseau en régime méso-épizonal lié à la déposition du GHS; **C)** inverse senestre mésozonal lié au racourcissement du GHS; **D)** normal et inverse épizonal lié à l'exhumation du GHS.

ANALYSE STRUCTURALE PRELIMINAIRE DES UNITES BORDANT LA FAILLE DE PORCUPINE-DESTOR DANS LE NORD-OUEST QUEBECOIS

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La région de l'étude se trouve à l'intérieur de la sous-province de l'Abitibi dans la province tectonique du Supérieur et l'ensemble des roches est métamorphisé au faciès prehnite-pumpellyite. La faille de Porcupine-Destor est orientée E-W à ESE et elle est inclinée vers le sud. Elle sépare des empilements de volcanites et elle est bordée par des bassins fluviatiles tardifs. Dans le secteur étudié, le grain structural est grossièrement E-O et la plupart des unités sont abruptes avec une polarité vers le sud. Le compartiment au nord de la faille comprend trois ensembles lithologiques distincts: 1) des basaltes tholéiitiques plissés selon un synclinal kilométrique, E-W et plongeant vers l'ouest, 2) un complexe tectonique se pinçant vers l'ouest et situé en ligne avec la charnière du grand synclinal et 3) des sédiments fluviatiles reposant en discordance d'érosion sur le complexe et plissés selon un synclinal ENE et plongeant faiblement vers l'ouest. La faille de Porcupine-Destor tronque toutes ces unités. Au sud de la faille de Porcupine-Destor, les unités volcaniques et sédimentaires suivent une flexure régionale orientée ENE-ESE qui longe la trace de la faille. Les plis deviennent plus ouverts en s'éloignant du nord au sud de la faille.

Les roches sont marquées par une schistosité E-W à ENE, inclinée vers le sud, qui recoupe transversalement les plis régionaux au sud et au nord de la faille. On observe peu de structure de recoupement à part un clivage de crénulation local dans les zones de haute déformation. Les rares marqueurs d'un plissement postérieur sont des plis mineurs en Z et fortement plongeants qui reprennent la schistosité. Les failles secondaires, presque toutes situées au nord de la Porcupine-Destor, sont abondantes dans le complexe tectonique. Elles sont orientées E-W à ENE et plus rarement ESE et leur pendage abrupt, incliné vers le nord ou vers le sud, avec des rejets principaux verticaux. La linéation d'étirement dominante, de part et d'autre de la faille de Porcupine-Destor, est fortement plongeante vers l'E et l'ESE et dans la zone de faille celle-ci plonge à 45° vers l'ESE. Les structures les plus tardives sont des veines de tension N-S et des failles NE et NO avec des mouvements respectivement senestre et dextre qui déplacent toutes les structures dont la Porcupine-Destor.

Les mesures préliminaires de l'ellipsoïde de la déformation finie montrent: 1) qu'au nord de la faille, l'aplatissement domine et que l'étirement est limité aux zones de failles secondaires, 2) qu'au sud, l'étirement prédomine et augmente de façon importante vers la faille, et 3) que la déformation augmente latéralement d'ouest en est. L'analyse structurale suggère que le déplacement principal le long de la faille de Porcupine-Destor dans le secteur étudié est un mouvement inverse vers le nord et le NNO, doublé d'un mouvement dextre tardif et que le secteur au nord de la faille où celle-ci est orienté ESE a subi une transpression dextre.

THE KINNAIRD PLUTON: A MULTIPLE GRANITIC SHEET

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The Cretaceous Kinnaird Pluton was emplaced into Paleozoic gneisses and metasediments of the Quesnel Terrane in southeast British Columbia south of latitude 49°20'N. Castlegar and its southern community of Kinnaird, in the Columbia valley, lie in the eastern portion of the body. The Pluton consist mainly of prophyritic (with K-feldspar megacrysts) hornblende, biotite quartz monzonite and granite. Its intrusive relationships and geometry are still clear in spite of strain, associated with Tertiary deformation. The Pluton is a gently west-dipping sheet, two to three kilometres thick with an outcrop area of some 300 km^2 and with its roof and floor locally exposed thanks to some 2000 m of vertical relief. The Pluton sonsist of a sequence of individual sheets, 50 to 250 m thick each, emplaced one next to the other. The contacts of the individual sheets are sharp and smooth with no chilling. Locally, decimetre and metre-thick country rock slabs decorate the contacts and are interpreted as dismembered screens. Thicker screens are found only near the roof in the northwestern part of the body. There, a screen of Jurassic tonalite up to 700 m thick and one of Pennsylvanian schist 100 to 200 m thick separate individual intrusive sheets. The presence of such screens with contacts parallel to foliation and layering, in conjunction with the fact that the basal contact is layer-parallel, demonstrates that emplacement of the Pluton was structurally controlled by the foliation and layering of the Paleozoic gneisses and schists.

In the southern part of the Pluton, where there are large clear exposures on the west side of the Columbia valley, individual sheets can be followed for thousands of metres. Rare apophyses form one sheet into the adjacent lower one suggests sequential emplacement in ascending order. Outcrop in the rest of the body is adequate to show that it is composed of separate sheets but were not able to map individual sheets continuously. The sheets may therefore be either continuous throughout the body or a stack of interleaved and overlapping lenses. It is proposed, therefore that the emplacement mechanism for some 800 km^3 of granitic magma was sequential intrusion of 50 m to 250 m thick sills guided by the pre-existing geometry of the country rocks and permitted by incremental litfting of the roof.

COMPLEX KINEMATICS, STRAIN RATE DISTRIBUTION AND MAGMA EMPLACEMENT IN AN ARCHEAN SEGMENT OF THE SNOWBIRD TECTONIC ZONE, N. SASKATCHEWAN

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The NE-SW trending Snowbird tectonic zone at the eastern end of Lake Athabasca, Northern Saskatchewan is represented by the extensive (130 * 85 * 80 km), granulite facies ca. 3.2-2.6 Ga. East Athabasca Mylonite Zone (Tantato Domain of authors). The triangular shaped mylonite zone is located at the NE end of a relatively stiff crustal-scale (300 * 100 km) 'boudin'. The map-scale (1:50,000) flow pattern within the mylonitic rocks was extremely complex and played a controlling role in the emplacement and distribution of syntectonic granitoids. The mylonite zone is divided into a variably, but extensively, mylonitic northern lower deck with upright NE-SW striking mylonitic foliations and shallowly SW plunging extension lineations, overlain to the south by a penetratively ultramylonitic arcuate upper deck. Within the upper deck, foliations dip shallowly to the SW along one side of the arc (trailing edge), but are upright and NE-SW striking along the other side (lateral ramp); extension lineations plunge shallowly to the SW. The lower deck mylonites are dextral in the west and sinistral in the east, with an intervening low-strain septum which experienced a bulk pure shear strain path; shear criteria in the upper deck mylonites consistently indicate top-down to the SW (hence the 'trailing edge'). Most of the East Athabasca Mylonite Zone tectonites are penetratively developed ribbon mylonites with few feldspar porphyroclasts. However, an anastomosing pattern of 1-2 km wide belts of highly porphyroclastic ultramylonites wrapping around porphyroclast-free ribbon gneisses was developed within the lower deck, under granulite facies conditions, at the expense of a common granitoid parent-rock, adjacent to the lateral ramp of the upper deck. We suggest that the map-scale pattern represents a regional increase in strain rates and consequent stiffening of the lower deck rheology due to the re-enforcing effect of dextral shear in both lower deck and upper deck as a consequence of the orientation of the flow planes within a 3D bulk flow. We further suggest that the ribbon gneisses developed at relatively slow strain rates, whereas the porphyroclastic ultramylonites formed at relatively elevated strain rates, but not at the expense of the ribbon gneisses. Voluminous sheets of late syntectonic granite were preferentially emplaced at two kinds of structurally controlled sites. The most voluminous were emplaced at the trailing edge of the upper deck. Other sheets up to 100's m thick were emplaced into the anastomosing belts of high strain rate ultramylonite. We suggest that these belts experienced short-term excursions into the pressure-sensitive brittle field, perhaps due to transient increases in strain rate. The bulk flow accommodated by the East Athabasca Mylonite Zone broadly corresponds to a regional progressive pure shear representing a consistent NW-SE shortening across the Snowbird tectonic zone.

Shear zone
A3.50 Cob

MEASURED AND CALCULATED P-WAVE VELOCITIES OF HIGH GRADE MYLONITES FROM THE SNOWBIRD TECTONIC ZONE (CANADA): IMPLICATIONS FOR THE SEISMIC ANISOTROPY AND REFLECTIVITY OF LOWER CRUSTAL FAULT ZONES

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In order to understand seismic anisotropy and its unfluence on the reflectivity of the lower crust, we have undertaken a study combining experimental measurements up to 600 MPa with theoretical calculations of P-wave velocities for 20 granulite and upper amphibolite facies mylonites from the Snowbird Tectonic Zone (Canada). The rocks, whose composition ranges from ultramafic to felsic, have experienced extremely large ductile strain. The P-wave velocities calculated according to the lattice preferred orientation (LPO), single crystal stiffness coefficients, density and volume fraction of each constituent mineral are in good agreement with those measured at high pressures. It is noted that the anisotropy calculated from the measured Vp differences between the X (lineation), Y (perpendicular to lineation in the foliation plane) and Z (normal to foliation) directions may not present the maximum anisotropy in some samples due to asymmetry of lattice preferred orientation (LPO) with respect to these axes. It is found that the amphibolitic mylonites exhibit significant Vp anisotropy (6-13% at 600 MPa), whereas the pyroxene-bearing granulite-facies mylonites and the quartz or feldspathic (tonalitic, granitic and anatexitic) mylonites are quasi-isotropic. The interaction between feldspar and quartz or pyroxene and the absence of amphibole cause anisotropy in the granulite mylonites to be low. The amphibolitic mylonites are strongly anisotropic because of a large volume fraction of hornblende with strong LPO ([001]//lineation, and (001)//foliation). The anisotropy pattern in the amphibolitic mylonites is consistently orthorhombic: $Vp(X) > Vp(Y) > Vp(Z)$, whereas that in the mica-rich mylonites is transversely isotropic: $Vp(X) = Vp(Y) > Vp(Z)$. This discrepancy may be an important indicator for kinematic analysis in the middle to lower srut using modern seismic techniques. Our study demonstrates that while the seismic reflectivity is strongly lithology-controlled, fabric-induced anisotropy can both enhance and decrease seismic reflectivity. Hence, the discontinuity of seismic reflections along ductile shear zones in the lower crust is not necessarily indicative of the discontinuity of the shear zones, but may indicate changes in composition or metamorphic grade.

MEASURED AND CALCULATED S-WAVE VELOCITIES AND SHEAR-WAVE SPLITTING IN HIGH GRADE MYLONITES: IMPLICATIONS FOR KINEMATICAL ANALYSIS IN THE LOWER CRUST

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Shear-wave velocities (Vs) for 10 high grade mylonites (granulite and upper amphibolite facies) from the Snowbird Tectonic Zone (Canada) have been measured at various pressures up to 600 MPa in order to explore the kinematical significance of shear-wave splitting in the lower crust. Good agreement between the calculated and measured S-wave velocities at high pressures indicates that the S-wave anisotropy and splitting is caused by the alignment of anisotropic minerals, rather than the alignment of cracks. At 600 MPa, Vs anisotropy ranges from 11% in the amphibolitic mylonites to 2% in the granulite facies pyroxene-bearing and tonalitic mylonites. Hornblende-bearing granitic mylonites display intermediate Vs anisotropy (6-7%). Vs anisotropies are lower than Vp anisotropies in the hornblende-rich mylonites, whereas Vs anisotropies are higher than Vp anisotropies in the feldspar-rich mafic, tonalitic, granitic and anatexitic mylonites. Shear-wave splitting (Vs) is strongly dependent on the orientation of propagation and polarization directions with respect to the foliation and lineation, and is often pronounced in rocks displaying strong S-wave anisotropy. In most of the lower crustal mylonites studied here, the polarization direction of the first arrival (Vs1) corresponds to the extension lineation (X) when propagation is parallel to Y (perpendicular to lineation and parallel to foliation) or tho the Y-direction when propagation is parallel to X. For all other propagations, the polarization direction of Vs1 is oblique to the X-,Y- and Z-directions. Therefore, it may be difficult to infer the structural implication of shear-wave splitting in the lower continental crust if one does not know (1) the orientation of the propagation and faster polarization directions with respect ot in-situ lineation and foliation, and (2) the lattice preferred orientation of in-situ rock-forming minerals.

STRUCTURAL CONTROLS AND TIMING OF MINERALIZATION IN THE SILL-HOSTED STOG'ER TIGHT GOLD DEPOSIT, BAIE VERTE PENINSULA, NORTHWESTERN NEWFOUNDLAND'.

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Structural elements within the Noranda Stog'er Tight Gold Deposit in the Baie Verte Peninsula, northwestern Newfoundland have been studied in order to determine the strucutral history of the area, the controls on gold mineralization and its relationship to the major fault zones. The Stog'er Tight deposit, a mesothermal altered wallrock gold deposit is hosted by differentiated gabbroic sills within the cover sequence of the Point Rousse Complex. It is located on the south limb of a regional easterly trending syncline of the Point Rousse Complex. The structures within the study area are dominated by a well-developed regional foliation that can contain a distinct, downdip stretching lineation. Overprinting relationships at the outcrop scale indicate that two distinct generations of folds and cleavage followed the development of the regional foliation.

Three phases of deformation affected the rocks of the area. The first phase of deformation (D_1) consisted of an intense ductile shearing which produced the regional foliation (S_1) and downdip lineation (L_1). The S_1 fabric dips to the north between 25° and 40° and is generally bedding-parallel. Near major ductile shear zones, the S_1 fabric intensifies and grades into a mylonitic foliation.

The D_1 ductile shear zones are structurally related to major faults of the Baie Verte Peninsula. These shear zones which are sub-parallel to other faults affecting the Point Rousse Complex are considered third order structures related to a more important first order structure, the Scrape Thrust, a major interblock fault. Variable intensities of hydrothermal alteration have been observed within faults of the Point Rousse area. Although no significant mineralization has been observed within the Scrape Thrust, major gold occurrences have been identified along second and third order shear zones (Deer Cove and Pine Cove).

Contribution to the Canada-Newfoundland Mineral Development Agreement, 1990-1994

ANALYSE STRUCTURALE D'UN TRONCON DE LA FAILLE PORCUPINE-DESTOR (FPD), ABITIBI-SUD, QUÉBEC

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La présente analyse structurale de la FPD est basée sur la cartographie à l'échelle 1:5000 du secteur de la mine Duquesne effectuée en 1989 dans le canton Destor. Cette analyse repose sur la carte géologique, la disposition géométrique des éléments structuraux en projection stéréographique et leurs descriptions mésoscopiques.

Les plans S0 et S1 sont pentés abruptement au sud et varient d'orientation ENE à ONO. La schistosité S1, pénétrative et homogène dans le secteur, contient une excellente linéation d'étirement dans le sens du pendage. Ces caractéristiques et la forme en galette de varioles déformées suggèrent une composante d'aplatissement prédominante pendant la phase D1. Aucune constance au niveau des mouvements verticaux (inverses et normaux) n'a été observée.

La phase D2 se manifeste par la présence de cisaillements verticaux ductiles E-W et ONO à mouvement dextre. Les cisaillements E-W sont disposés en échelon avec un angle de 30 degrés à partir des cisaillements ONO produisant ainsi une géométrie en queue de cheval. L'intensité de cette déformation est très hétérogène dans le secteur. Certains cisaillements n'affectent que la partie sommitale (argilite) des lits sans perturber la polarité stratigraphique. A d'autres endroits, des plis (P1?) sans racines et une foliation mylonitique sont observés. Des plis asymétriques en Z à plongée variable vers l'ouest avec un clivage de plan axial "apparent" orienté ENE sont associés aux cisaillements. Des corridors de failles fragiles NNO (senestres) et NE (dextres) contenant des veines de tension ONO indiquent une compression dans cette direction. Des cisaillements fragiles ENE à mouvement senestre recoupent tous les autres éléments structuraux; ceux-ci représentent possiblement des structures en étagères.

Un réseau de failles fragiles NO (dextre) et NE (senestre) exprime une compression N-S tardive de faible importance observée dans l'ensemble du secteur.

Nos observations le long du troncon de la FPD étudié suggèrent que: 1) les phases D1 et D2 sont respectivement dominées par des mécanismes d'aplatissement et de cisaillement, 2) durant la phase D2, les cisaillements E-W (plan P) (et les plis en Z) se sont développées uniquement au "nord" des cisaillements ONO (plan C) afin de transmettre le glissement latéral dans les foliations "susjacentes", 3) les plis kilométriques en forme de Z visibles sur la carte géologique et les levés magnétiques au nord de la FPD sont interprétés comme des plis P2 macroscopiques, 4) la phase D2 est responsable des variations d'orientation ENE à ONO des plans S0 et S1.

SHAPE PREFERRED ORIENTATION OF MAGMATIC GRANITE SUB-FABRICS USING IMAGE ANALYSIS

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Preferred Shape Orientation (PSO) analysis from digital images, after data collection by CCD camera and digital phase separation, is obtained from rose diagrams of intercepts between a rotating grid and a fixed image. Digital phase separation is achieved using the principles of multispectral analysis after staining feldspars in the sample. The intrinsic anisotropy of pixels has been eliminated using a linear sliding mask. Applications of this technique have allowed calibration of PSO intensity of PSO sub-fabrics of biotite, plagioclase, K-feldspar and quartz in the Mont Louis-Andorra Granite in the eastern Pyrenees. Obliquity between early crystallizing phases in these rocks can be used as a kinematic indicator of the latest stage of emplacement-related magmatic flow, after considering the influence of grain-to-grain interaction.

Measurements were made on the XZ plane of the AMS ellipsoid determined for each sample. 7 southwest verging biotite-plagioclase sub-fabric obliquities have been determined for 12 samples from 5 locations, as opposed to only 2 northeast verging obliquities. If free grain rotation is assumed these obliquities indicate southwest directed shearing during emplacement. However, grain-to-grain interaction appears to have been important during late stage flow of the magma, so that the observed obliquity can only be interpreted with a better understanding of such interaction effects. The PSO of other minerals can help to solve this problem. For example measurement of rare, interstitial K-feldspar in one sample shows a ca. 45° obliquity to the biotite PSO. This may indicate the orientation of tension cracks formed during sub-magmatic flow at the final stages of emplacement. In this sample both the K-feldspar PSO and the biotite-plagioclase obliquity indicate northeast directed shearing.

This work emphasizes the importance of determining several sub-fabric PSO's from a large number of samples in order to interpret the kinematics of magmatic flow with confidence.

TECTONOSTRATIGRAPHIC SETTING OF THE HUMBER ZONE IN THE MONTMAGNY-BELLECHASSE AREA

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The last four years of geological mapping in the Montmagny-Bellechasse area have permitted a better understanding of its tectonostratigraphic setting in the Humber zone. Second order tectonostratigraphic elements have been identified as thrust nappes. These nappes are defined by their distinct internal lithofacies and structures. Each thrust nappe is bounded by thrust faults and shows internal minor folds and thrust slices. Five nappes are defined. From NW to SE, they are: the Bacchus nappe (BCN), the Rivière Boyer nappe (RBN), the Richardson nappe (RCN), the Rosaire nappe (RSN) and the Bennett nappe (BTN). The BCN, restricted to the Island of Orleans and a portion of the south shore of the St.Lawrence, shows anomalous N-S trending faults and folds near Quebec City which change orientation towards the north before merging with the NE-SW-trending Logan's Line. This nappe contains Lower Cambrian to Mid-Ordovician sedimentary units (the Ile d'Orleans Group) whose lithofacies are very distinct from those of the same age present in the next higher structural unit, the RBN. The latter nappe contains sedimentary units that extend from the Etchemin River to the Gaspe peninsula, namely the Saint-Roch Formation, the Trois-Pistoles Group and the Rivière-Ouelle Formation. The Richardson thrust fault, which extends from the Chaudière River to the Riviere-du-Loup area, brings the RCN over the RBN. The RCN comprises sedimentary rocks which have not yielded fossils but contain lithofacies that can be linked with those found in the RBN. It comprises a lower and thick (7000-8000 m) arkosic unit, the Armagh Formation, correlative with the Saint-Roch Formation and a higher, cleaner, more quartzitic unit correlative with the Trois-Pistoles Group. The repetition of the Armagh has permitted the definition of several thrust faults, one of which marks the greenschist isograd.

The RSN contains overturned schistose metaquartzite and phyllite, apparently correlative with the Trois-Pistoles Group. The BTN presents the same rocks, but at a higher metamorphic grade, in addition to thin ultramafic sheets.

A regional cross-section shows that the architecture of the thrust belt in the Montmagny-Bellechasse area is that of a SE dipping and thickening wedge formed of a series of thrust nappes which moved NW. The higher nappes have been folded and are now overturned toward the SE. This structural framework is very different from former interpretations and permits the reconsideration of the sedimentary and structural evolution of a large segment of the Humber zone.

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THE GEOMETRICAL RELATIONSHIP BETWEEN THE STRETCHING LINEATION AND THE MOVEMENT DIRECTION OF THE SHEAR ZONE

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The internal structure of shear zones generally has monoclinic symmetry. The symmetry plane is perpendicular to the intersection of the shape fabric (S-foliation) and the shear zone boundary and contains the stretching lineation, the shear direction and the poles to the S-foliation. It is the orthogonal projection of the stretching lineation on the shear zone boundary, not the stretching lineation itself, that is parallel to the shear direction. Unless the movement is truly strike-slip and the shear zone is vertical, the plunge of the shear direction is not equal to that of the stretching lineation. Qualitatively the point is obvious; what is not so obvious is that the magnitude of the potential error is likely to be significant, as is clear from a quantitative study.

A consistently shallowly plunging stretching lineation on a steeply dipping foliation in a shear zone is commonly interpreted as indicating strike-slip motion with a minor vertical component. This study shows that this may not necessarily be true. For example, the stretching lineation formed in a true strike-slip shear zone dipping 60° would pitch 16° (plunge 14°) on S dipping 64°, if the angle between S and C is 30°. Movement on such a shear zone could be hundreds of kilometres. However, if the stretching lineation were correlated with the movement direction, there would be ca. 2.6 km dip-slip for every 10 km strike-slip, and if there is no metamorphic change across the fault, we would conclude, perhaps erroneously, that the movement could be no more than 10-20 km. Faults with such geometry are known in the Canadian Appalachians.

Steeply plunging stretching lineations on steeply dipping foliations in shear zones are usually interpreted as indicating dominant dip-slip movement with only a minor horizontal component. However, this also may not necessarily be true. For example, sinistral reverse movement along a shear zone dipping 45° with movement direction pitching 45° (plunging 30°) would form a stretching lineation pitching 58° (plunging 52°) on a foliation dipping 69°, if the angle between S and C is 30°. Shear zones with such a geometry may be common in positive flower structures.

The stretching lineation and the S-foliation can be used to determine the shear direction if either the attitude or the strike of the shear zone is known. The true shear direction is parallel to the intersection of the symmetry plane and the shear zone boundary. The former is defined by the stretching lineation and the poles to the S-foliation. The latter, if cannot be measured directly in the field, is parallel to the plane defined by the shear zone strike and the pole to the symmetry plane.

IMBRICATE THRUSTING, REVERSE FAULTING, AND LATE EXTENSION IN THE ACADIAN OROGEN OF THE CENTRAL CAPE BRETON HIGHLANDS, NOVA SCOTIA

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Deformation within the Acadian orogen of the central Cape Breton Highlands features: a) mid-crustal west-vergent imbricate thrusting within the Jumping Brook Complex; b) opposite facing reverse fault systems which displace deep crustal rocks of high metamorphic grade over medium to low grade volcanic arc assemblages; and c) late extension.

Imbricate thrusting within the Jumping Brook complex is marked by structural repetitions of a turbiditic sequence and associated metavolcanic assemblage. The footwall to hanging wall transition of the western-most exposed thrust corresponds with the greenschist to amphibolite transition, and with the almandine isograd. The eastern boundary of the Jumping Brook Complex is truncated by a west-directed reverse fault which separates it from high grade orthogneiss of the Pleasant Bay Complex. Syn-kinematic staurolite is a distinctive feature of this fault, and occurs in pelitic members of the immediate footwall. Further to the east, east-directed reverse faulting along the Eastern Highlands Shear Zone juxtaposes high grade gneissic rocks against low grade supracrustal volcanic arc assemblages. This shear zone also contains associated staurolite, is mylonitic, and is strongly folded, possibly having been deformed by the west-verging faults.

Elements of extensional tectonics are well developed in the west within the Jumping Brook Complex and surrounding rocks. These include moderate to shallowly-dipping mylonite zones which have a domed distribution. The mylonites merge with, and are rooted in, the earlier formed thrust and reverse faults which appear to have been reactivated during this later phase of deformation. Available Kinematic indicators, mineral lineations and kink bands indicate a predominantly northward movement of the upper sheets during extension. Denudation is further demonstrated by sedimentation and deposition of volcanic rocks from the Upper Devonian Fisset Brook Formation upon units situated at the lowermost structural levels.

SUPERPLASTICITY IN STRAIGHT GNEISSES

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In the Ontario segment of the Grenville Structural Province the margins of high metamorphic grade thrust sheets are outlined by highly deformed banded gneisses, often described as "straight gneisses" (Hanmer 1988). Many of these highly deformed upper amphibolite to granulite facies gneisses exhibit layers that are continuous over tens of metres, with very little evidence of boudinage or pinch-and-swell. Individual layers of quartzo-feldspathic and amphibolitic composition thus pose the rheological question of how the layers remained unboudinaged during deformation. This work examines the conditions under which boudinage or pinch-and-swell does or does not occur. The modelling is based on the single-layer shearing instability theory of Smith (1975, 1977). No significant pinch-and-swell occurs for linearly viscous materials, regardless of viscosity contrast, even for strains as large as 1000%. Pinch-and-swell seems to require a power-law viscosity (stress-exponent, n 3). The deformation of straight gneisses thus seems to require that they be approximately linearly viscous, or at least a low stress-exponent viscosity ($n < 3$). This "superplastic" behaviour suggests that grain-boundary sliding and diffusion creep may play an important role in the deformation of gneisses at high metamorphic grades.

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The growth rates of the amplitude of a pinch-and-swell disturbance on a more viscous layer embedded in a less viscous medium were calculated for different viscosity ratios, disturbance wavelength/layer thickness ratios, and viscous rheologies.

Using the instantaneous growth rates, stepwise calculations were used to observe the effects of cumulative strain on the growth of the pinch-and-swell disturbance under plane strain of the layer(s).

STRUCTURALLY-CONTROLLED MINERALIZATION ALONG THE GRAND PABOS FAULT, SOUTHERN GASPE PENINSULA, QUEBEC APPALACHIANS: A PRELIMINARY STUDY

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In the southern Gaspé Peninsula, most of the mineralized zones are spatially associated with the Grand Pabos fault (GPF) or some secondary faults. The GPF is a major dextral strike-slip fault related to a transpressive regime of deformation during the Middle Devonian Acadian orogeny. The fault of a zone of high strain which contrasts with the mildly to moderatly regional deformation characterized by upright and open NE-SW striking doubly-plunging folds accompanied by a well-developed penetrative cleavage. Within zones bordering the fault, the regional cleaveage is deformed by late shear fabrics.

Gold and Cu-skarn occurrences are two types of structurally-controlled deposits along the GPF. The polymetallic Reboul prospect contains both metal-rich skarns and precious metal-rich vein mineralization. These mineralisations are hosted by lower Silurian limestones on the northern side of the E-W striking GPF. Skarn and early Cu-Zn-Ag mineralization are confined to a zone of impure limestone and were emplaced on the highly fractured southern limb of a major regional anticline. Subsequent Cu-Zn-Pb-Ag-(Au) mineralisation, hosted by massive quartz-calcite veins, is located in NW-SE extensional veins and along NE-SW limb thrust faults. Late Ag-Au-Zn-Pb-bearing quartz breccia veins are located in shears parallel to the GPF. Structural settings for these three mineralisations are all compatible with an E-W dextral strike-slip fault such as the GPF.

Vein-type gold minaralisation is another important example of structurally-controlled mineralisation along the GPF. In the Lac Arsenault area, gold mineralisation is contained within 10 to 50 cm thick massive and/or laminated quartz veins embedded in Middle Ordovician greywacke. Four main gold-bearing quartz veins are located between the E-W striking GPF and a secondary dextral strike-slip fault oriented N120E. A preliminary study shows that the veins are enclosed and subparallel to sinistral NNE striking small-scale brittle-ductile shear zones. The exact relationship between all these structural elements (veins, sinistral shear zones, secondary dextral fault and the GPF) is still unclear and more field work is necessary. In the Saint-André-de-Restigouche area, a 20 to 80 cm thick quartz-stibnite vein contains the gold mineralisation. The vein, located to the south of the Matapédia fault, is embedded in limestone of Early Silurian age. It is vertical and oriented N124E whereas the Matapédia fault is oriented N070E. The Matapédia fault is in the western extension of the GPF and has also a dextral strike-slip component of movement. The vein is approximately at 45° to the fault which is the theoretical extension field for a dextral strike-slip fault. This relationship suggests compatibility between the fault an the hosting structure of the extensional quartz veins.

The structural compatibility between the hosting structures and kinematics along the GPF demonstrates that Acadian strike-slip tectonics played a major role in the structural setting of the mineralisations providing channelways for ore-bearing fluids.

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SYNTHÈSE GÉOLOGIQUE ET MÉTALLOGÉNIQUE DE L'ESTRIE-BEAUCE : Feuillet 31H/01 - Memphrémagog

Robert Marquis, Ministère de l'Énergie et des Ressources

Afin d'améliorer la diffusion de l'information géologique et métallogénique disponible pour les Appalaches du sud du Québec, le MER prépare une nouvelle collection de cartes métallogéniques couvrant l'Estrie et la Beauce, à l'échelle du 1:50 000. L'information géologique nouvelle concerne en particulier les environnements de dépôt des différentes lithologies qui seront identifiés indépendamment de la nomenclature stratigraphique traditionnelle.

Le feuillet 31H/01 Memphrémagog chevauche les zones d'Humber et de Dunnage. La limite entre ces deux zones est marquée par un alignement de lentilles ultramafiques et par un contraste de style tectonique frappant. Pour respecter ce contraste, nous proposons de repousser la ligne Brompton-Baie Verte à l'ouest de la Formation d'Ottauquechee, un assemblage de métagrès et de phyllade noir qui pourrait être équivalent latéralement au Groupe de Caldwell. La compilation de ce feuillet permet également d'identifier une déformation précoce dans la zone de Dunnage. Cette déformation affecte la Formation d'Ottauquechee, les terrains cambro-ordoviciens structurés dans le Complexe de St-Daniel et les grès de la Colline Bunker, à l'est du Lac Memphrémagog. La déformation régionale acadienne a produit une schistosité pénétrative bien développée dans les siltstones et les mudslates. Cette schistosité régionale tend à se parralléliser avec les grandes failles que sont la ligne Brompton-Baie Verte et la Faille de la Guadeloupe, ce qui provoque un changement systématique et graduel d'attitude du nord vers le nord-est.

Une information nouvelle concerne les corrélations structurales de part et d'autre de la ligne Brompton-Baie Verte et l'âge de la déformation dans la zone d'Humber. Une interprétation de linéaments satellites suggère qu'un clivage de crénulation tardif de la zone d'Humber orienté est-nord-est pourrait être acadien. Ce clivage le plus jeune de la zone d'Humber se superpose à trois phases de déformation affectant la Suite métamorphique de Sutton. Il est compatible avec un déplacement senestre acadien le long du segment sud de la ligne Brompton-Baie Verte. Par conséquent, il pourrait être contemporain à la schistosité régionale acadienne de la zone de Dunnage. Finalement, un réseau de failles tardives déterminé par géologie et par géophysique est contemporain de la mise en place de lamprophyres et de dykes de syénite Crétacé.

PROBLÉMATIQUE DU FRONT DU GRENVILLE A L'EST DE L'AXE SENNETERRE-LOUVICOURT

James Moorhead, Réjean Girard et **Tyson Birkett**, Université du Québec à Chicoutimi.

Suite à une nouvelle cartographie dans la province du Grenville à l'est de la ceinture de roches vertes archéennes de l'Abitibi, la problématique du Front du Grenville (FG) et de l'origine des séquences parautochtones dans ce secteur est ici abordée. Les gneiss grenvilliens dans la portion sud du secteur se composent dominamment de séquences méta-supracrustales, soit 50 % de paragneiss, 25 % de gneiss mafiques et 25 % de gneiss leucocrates d'origine indéterminée. Quoique possédant des assemblages lithologiques semblables à ceux des ceintures volcaniques et sédimentaires des sous-provinces d'Abitibi et Pontiac, aucune corrélation directe ne peut être établie à ce jour. Le secteur nord se compose de massifs tonalitiques en continuïtés cartographiques avec les tonalites de la province du Supérieur.

Le segment sud du FG dans ce secteur est orienté ENE. Une zone de mylonite anastomosée de +/- 1 km y juxtapose les gneiss grenvilliens contre les roches de la province du Supérieur. Les gneiss, au faciès des granulites partiellement rétromorphosés aux faciès des amphibolites, sont chevauchés vers le NNE sur les séquences volcano-sédimentaires archéennes au faciès des amphibolites inférieures au sud et contre la tonalite de Faillon au centre. La gradation métamorphique est abrupte sur moins de 5 km.

Le segment nord du FG dans le secteur est orienté NNE et juxtapose les gneiss grenvilliens contre la tonalite de Faillon. Plus au nord, le FG possède des tonalites de part et d'autre, rendant son identification difficile. Un décalage senestre sur environ 60 kilomètres est ainsi déduit. Le style tectonique de ce segment est complexe, montrant la superposition de plusieurs familles de tectonites. La gneissosité moyenne s'oriente parallèlement au front, tronquant ainsi le grain tectonique NO-SE des tonalites adjacentes. Cette gneissosité s'accompagne d'une linéation marquée plongeant modérément vers le sud-est. Un mouvement inverse à composante senestre est indiqué dans un régime pré à syn-métamorphique. Toutefois, les indicateurs cinématiques sont conflictuels, une composante en rétrocharriage est aussi présente. Une zone de mylonite anastomosée se superpose à la gneissosité à proximité du front. Une rétromorphose au faciès des amphibolites inférieures indique leur nature post-métamorphique. Les indicateurs cinématiques, le long d'une linéation d'étirement plongeant modérément vers le SE, sont inconsistants, tant inverses que normaux. Finalement, une série de failles tardives, associées à une épidotisation et hématitisation, affecte la zone du front et les tonalites de l'avant-pays. Ces failles forment des linéaments NNE parallèles à ce segment du FG.

BREAKBACK THRUSTING AND ASSOCIATED METAMORPHISM AT MID- TO DEEP CRUST, SOUTHWESTERN CENTRAL GNEISS BELT, GRENVILLE OROGEN

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The tectonic and thermal evolution of the Central Gneiss Belt, southwestern Grenville orogen, does not conform to simple models of collisional belts. In the Huntsville area, the Algonquin thrust stack comprises a set of northwest-transported crystalline thrust sheets bounded by granulite to upper amphibolite facies thrust zones. Map-scale cross-cutting relationships and geochronological data demonstrate that the assembly of this stack and the subsequent emplacement of the extensive, overlying Seguin and Moon River thrust sheets, represents a breakback thrust sequence. Moreover, at the scale of the entire southwestern Grenville orogen, the northwestern limit of major thrusting migrates southeastward, i. e. up structural section, with time.

The thermal history of the area is marked by a major crustal thickening event prior to final-stage thrusting of the Parry Sound thrust sheet at ca. 1160 Ma and the emplacement, in mid- to deep crust, of coronitic olivine metagabbro at ca. 1170 Ma. The Algonquin thrust stack is interpreted as a product of this thickening event. Intense ductile regional deformation under uppermost amphibolite and/or granulite facies conditions followed emplacement of the coronitic metagabbro and occurred prior to late-stage breakback thrust movement at ca. 1100 Ma of the Seguin and Moon River thrust sheets.

Thermobarometric data from post-peak metamorphic, annealed and retrograded, syntectonic mineral assemblages coupled with peak metamorphic data from pristine granulite facies mafic assemblages define a P-T trajectroy which traverses the sillimanite stability field. This trajectory probably depicts the P-T-time path experienced by the rocks exposed at the present erosional surface. The post-thrusting high temperature part of the cooling history is constrained by a minimum age limit ca. 1100 Ma for peak metamorphism, the ca. 1067 Ma monazite blocking ages at ca. 700°C and ca. 500°C $^{40}Ar/^{39}Ar$ hornblende cooling ages. High temperature conditions were maintained in excess of 35 Ma from peak metamorphic conditions to cooling to ca. 700°C at ca. 1067 Ma. Clearly, the early part of the cooling path is non linear and cooling rates much greater than 10°C/Ma can be modelled.

Taken together this data demonstrate that if the crustal thickening and high grade metamorphism in the Central Gneiss Belt resulted from the accretion of the Central Metasedimentary Belt, initial thrusting in the Central Metasedimentary Belt boundary thrust zone must predate ca. 1160 Ma.

A MODEL FOR ALBITE FLAME GROWTH

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A model is proposed for the development of albite flames in orthoclase at points of stress concentration as a result of i) the instability of oligoclase and, ii) the hydration of K-feldspar under conditions of retrograde metamorphism during thrust faulting.

Thin sections cut from a sequence of granite mylonites collected across the Grenville Front Tectonic zone in Ontario, contain three feldspar compositions. Microprobe analyses show these phases to be orthoclase (Or_{92-97}), albite and oligoclase. Invariably the three phases occur as distinct clusters on a ternary feldspar diagram. The albite occurs most commonly as flames which appear to be growing into the orthoclase. In general, flames can be found in typical tension-fracture locations, similar to sigmoidal quartz-tension gashes, in a direction parallel to the principal stress direction as indicated by the asymmetry of the mylonitic fabric. Flames also occur in a generally radial pattern around feldspar-feldspar grain contacts; the host, however, does not exhibit internal deformation that can be related to the number or size of albite flames it contains. In this model, the driving force for flame growth is provided by the instability of oligoclase combined with the hydration of orthoclase under conditions of high differential stress and retrograde metamorphism which are common in thrust faults. The anorthite component of the oligoclase breaks down to produce zoisite while excess Si and Al are combined with K liberated from the K-feldspar to produce muscovite i.e. sericitization of the plagioclase. Most of the albite component of the oligoclase remains in the host plagioclase while some Na is made available to replace the K which formed muscovite. The replacement is such that Na and K are the only components which must migrate a significant distance (from one grain to the next). The following total reaction is proposed:

$$16\ \text{Oligoclase} + \text{K-feldspar} + 2\ H_2O =$$
$$2\ \text{Zoisite} + \text{Muscovite} + 2\ \text{Quartz} + 11\ \text{Albite}_{\text{plagioclase}} + \text{Albite}_{\text{flame}}$$

During alteration the plagioclase changes shape thereby relieving the high differential stress imposed on these feldspar grains while the K-feldspar grains must sustain it. The flames apparently initiate along fractures or cleavage planes with the length parallel to the maximum stress direction such that the replacement front moves in the direction of lowest stress. The composition of the albite flames is controlled by the peristerite immiscibility gap and depends upon the position of the solvus at the pressure and temperature which existed during thrusting. Unlike other perthite morphologies, albite flame growth in flame perthites is unrelated to alkali feldspar exsolution.

migrate of Na in low pressure zones

STRAIN FABRIC PATTERNS IN IDEALLY DUCTILE TRANSPRESSIVE ZONES

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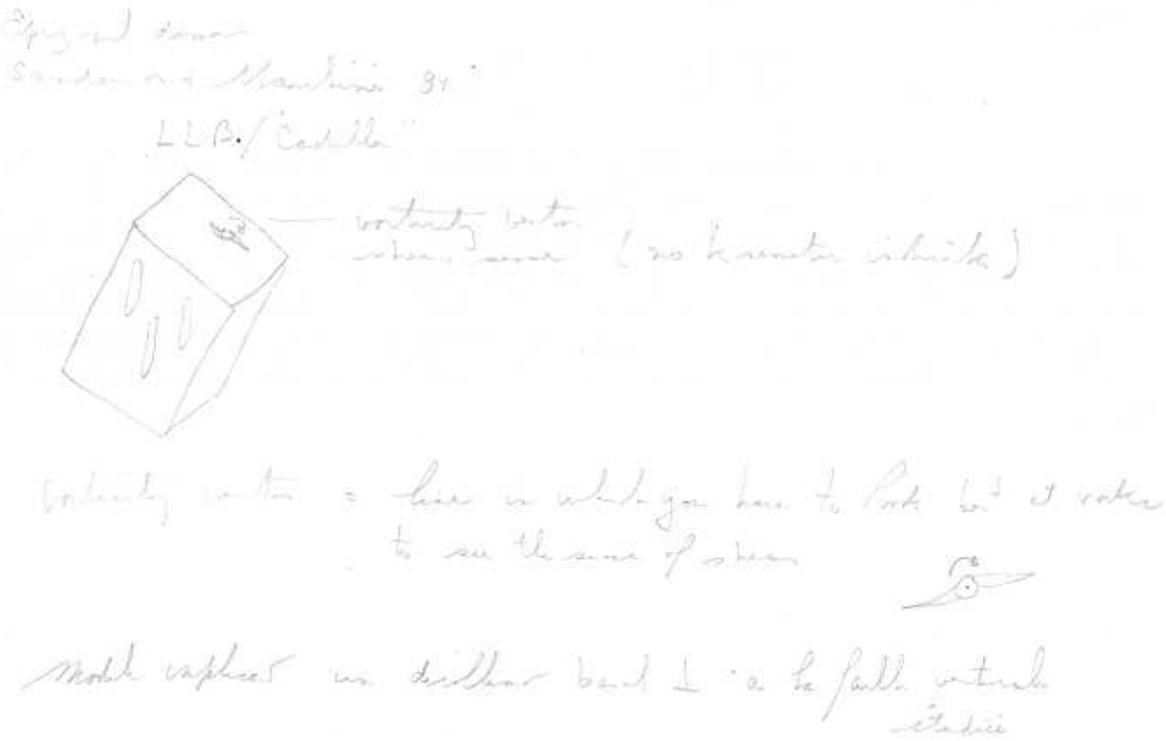
Some ductile shear zones exhibit an amount of coaxial flattening, and/or a pattern of fabric indicators which appear to be incompatible with the assumptions of plane strain and progressive simple shear commonly made for such shear zones. In the Archean Larder Lake Break (LLB), for example, internal vorticity indicators (asymmetric pressure wings, Z-folds, S-C fabrics), best seen on horizontal surfaces, indicate dextral transcurrent motion, whereas stretching lineations have steep but variable plunges. Rather than invoke two stages of deformation, we explore the possibility that the departure from plane strain could be the result of ductile transpression.

Ductile transpression implies an extrusion of material out of the shear zone. When the material cannot slip freely along the boundaries of the zone, the extrusion strain is heterogeneous and non-planar. We have modelled the 'transpressed' rock as a linear viscous material squeezed upward between two parallel, rigid, 'no-slip' walls. The 'lineation' is the direction of maximum principal incremental strain, the 'foliation' is the plane defined by the directions of maximum and intermediate principal incremental strains, and the internal vorticity vector is given by the velocity tensor.

In the predicted fabric patterns: (1) in the centre of the zone, lineations are vertical (for 'trans'/'press' < 2.5), but vorticity indicators are best seen on horizontal surfaces (i.e. the vorticity vector is vertical), as in the LLB; (2) vorticity directions are variable, strongest along the borders of the zone where vorticity is dominated by the extrusion process, and weakest in the centre, where it documents the shear sense; (3) 'foliation' and 'lineation' directions are variable.



TECTONIC TRANSPORT ANALYSES IN THE EUREKA SOUND FOLD BELT, ARCTIC CANADA

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Fold and fault structures in the Eureka Sound Fold Belt form a large-scale triangle on Axel Heiberg and Northwestern Ellesmere Islands. Complicated patterns of tectonic transport, i. e. the directions in which fold limbs or fault blocks moved relatively to each other, can be expected in such a non-cylindrical orogen.

Slickenside striations on small-scale faults and on pebble surfaces represent small-scale displacements (Schrader 1988), the directions of which define 3-D arrays containing, among other directions, the direction of maximum contraction (AD). Small particles in a faulted rock as well as large-scale fault blocks and fold limbs approached each other along the direction AD. By determining AD of the striation fabric, the tectonic transport in parts of the orogen may be constrained.

Studies were carried out on the SW side of the Eureka triangle at the Stolz fault zone near Whitsunday Bay and Buchanan Lake. The general orientation of the fault zone at one site is approximately prependicular to that at the other site. Either the displacement charcter (reverse or strike-slip) of the fault zone varies between both sites, or the tectonic transport is oblique and normal to the fault zone. One fault segment was studied on the N side of the Eureka triangle, in the Van Hauen fault zone (Lloyd and Schwerdtner 1990). Because this fault zone is not connected to the Stolz fault zone, their tectonic transport directions cannot be linked directly but may be understood in the context of the whole Eureka orogen.

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CONTRACTION FOLDS AS SHEAR SENSE INDICATORS

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The shortening of quasi-planar structures generally results in buckling or passsive amplification of geometric asperities (Ramberg, 1963, 1964). Such folds, which can be nearly cylindrical or markedly noncylindrical, are herein called "contraction folds". In cross section, they have S and Z geometry unless the fold enveloping surfaces remained normal to a principal direction of bulk strain. A computer simulation of passive folding in a zone of homogeneous simple shear (Ramsay et al., 1983, fig. 4) serves to illustrate important points that apply also to buckle folds. Note, however, that the final geometry of simulated folds can equally well be produced by obliquely superimposing a state of finite pure shear on the gentle fold in their fig. 4. The simulation serves to show that the asymmetry of contraction folds is an insufficient criterion for reconstructing the sense of bulk displacement along ductile shear zones. The following rules apply to all ductile regimes (not just shear zones) that contain contraction folds.

(1) The asymmetry (s versus Z) of contraction folds depends primarily on the sense of the component of cumulative shear strain that is parallel to the fold enveloping surface.

(2) Two types of S or Z folds may be distinguished: a low-strain type in which both fold limbs are in a state of cumulative shortening, and a high-strain type in which at least one limb is in a state of cumulative extension. Longitudinal-strain gauges are required to identify these types.

(3) The sense of shear strain on a fold enveloping surface may be opposite to the sense of bulk displacement along a shear zone boundary, even if the two structural surfaces make a small angle.

(4) The direction of resultant shear strain on fold enveloping surfaces is commonly indeterminate.

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A CLADISTIC ANALYSIS OF THE CONSTRUCTION OF THE SUPERIOR PROVINCE: A REPRESENTATION OF ONE HYPOTHESIS

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A cladogram is presented which summarizes the complex time-space relationships amongst tectono-stratigraphic assemblages, terranes and superterranes proposed to compose the Superior Province in northwestern Ontario. Different hypotheses can be advocated for these relationships; one hypothesis is presented as an illustration.

A cladogram is a branching diagram, commonly used in biosystematics to reconstruct the phylogeny of plant or animal species. G.C. Young (J. Geol. 1986, v.94, p.523-537.) has demonstrated the application of cladistics to Paleozoic continental reconstruction. This poster is intended to show that cladistics is likewise a useful method to display the sequence of events, the interrelations between crustal blocks (assemblages, terranes,...) and the timing of assembly of these crustal pieces to form an Archean craton. A cladogram can be organized to resemble a hierarchical time-space chart, with branching lines converging from tectono-stratigraphic assemblages or terranes toward a common time line that originates from the formation of a mass of older crust. The converging branches represent accretionary events or other crustal additions.

The Archean Superior Province is viewed as having been constructed through two basic stages: 1) the internal construction of subprovince-scale superterranes or composite terranes and 2) the assembly of these superterranes to form the Superior Province craton during the Kenoran Orogeny at about 2.7 Ga. The assembly of different tectonic components of an Archean subprovince is contrained by different magmatic and deformational events that can be dated. The cladogram portrays one scenario where the oldest rocks, concentrated in part of the Sachigo Subprovince formed the core of a microcontinent to which younger Archean crust was added at episodic intervals. The Uchi Subprovince, along the southern flank of the Sachigo Subprovince, reveals episodic additions of crust (stage 1 of above) onto the North Caribou terrane until the convergence and collision with other terranes from the south during the Kenoran Orogeny (stage 2).

This work, in progress, is an outgrowth of the development of a tectono-stratigraphic assemblage map for Ontario, to be published as one of a series of maps at a scale of 1:1 000 000 to commemorate the centennial of the establishment of an Ontario Bureau of Mines.

TRANSIENT DISCONTINUITIES REVISISTED - FRICTIONAL MELTS AND MYLONITES

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Large volumes of pseudotachylite occur in association with both mylonites and intense cataclasites within portions of the Outer Hebrides thrust, Isle of Lewis, Scotland. The mutual occurrence of apparently cyclically generated frictional melts (pseudotachylite) and mylonites deformed in the solid state provides one of the most extreme juxtapositions of deformation mechanisms evident within crustal rocks *i.e.* high-stress, temporally transient seismic events appear to coexist with high-grade, ductily deformed and dynamically recrystallized mylonites. Despite the interesting mechanical ambiguities exhibited by these rocks, their extreme fine-grained nature (grain size $< 1\mu m$) has precluded all but cursory microstructural examinations. Current electron microscopical and microanalytical studies of these rocks are pursuing clarification of the origin of both the pseudotachylite and the ultramylonite. Pristine pseudotachylite veinlets comprise angular fragments within a submicrometre polymineralic matrix, comprising primarily plagioclase and amphibole. Matrix textures locally exhibit complete wetting of one phase by another with resorption of fragments and diffuse boundaries with the host rock, all of which favour a melt origin for the pseudotachylite. Subsequent ductile deformation of veinlets produces a marginally coarser-grained ultramylonite. Intracrystalline deformation appears to be subsidiary to interface-controlled mechanisms that induce substantial superplasticity in the cooled melt. Microanalysis of amphibole and plagioclase that dynamically recrystallized in conjunction with the ultramylonite development suggests that amphibolite grade conditions were in effect throughout the pseudotachylite-mylonite-pseudotachylite cycle. The general absence of retrograde hydration reactions is also consistent with a fairly deep level origin for both brittle and ductile microstructures. A conservative estimate of deformation temperature of 500° C in a geothermal gradient of 20° km^{-1} suggests pseudotachylite formation at a depth of 25 km, well below the expected continental seismogenic regime. However, such conditions are comparable to seismic events within stable crust e.g. 1988 Saguenay event. A persistent problem with such a correlation is the identification of the mechanism by which the differential stresses required for dry thrusting (2 GPa) are developed.

which is very high

in active ductile shear zone, deep in the crust
amphibolite to granulite facies
mostly amphibolite

"Byerlee law"

T has to be high enough to melt it at 0.7 change cooling of melt
in half a year.

TRANSPRESSIVE DEFORMATION AT BROKEN HILL, AUSTRALIA AND THE PROBLEM OF VERTICAL LINEATIONS IN TRANSCURRENT SHEAR ZONES

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The Little Broken Hill area south of Broken Hill is characterised by sillimanite grade metamorphic rocks including sillimanite gneiss and schist, garnet biotite gneiss, large deformed pegmatite bodies, amphibolites, banded ironstones and Broken Hill type mineralisation. The regional foliation (S_1) is a product of intense transposition and dips generally at moderate angles in a northwestly direction. A prominent mineral lineation that is best developed in the sillimanite bearing rocks lies in the foliation and plunges shallowly in a southwestly direction.

The early transposition fabric is overprinted by a set of vertical, northwesterly trending dolerite dykes and numerous approximately vertical shear zones that trend northeasterly and noerthwesterly. Both sets of shear zones are characterized by a new foliation and a stretching lineation that plunges parallel to their mutual line of intersection. There is no consistent overprinting relationship between the shear zones which suggests that they are contemporaneous. Their conjugate geometry with a vertical intersection, large horizontal separation of markers and general fabric symmetry indicate that despite the orientation of the stretching lineation the shear zones were transcurrent.

The northwestly trending zones can be divided into two groups: (a) Simple zones with dextral horizontal separation, sympathetic "drag" of S_1 and a vertical, sigmoidal shear zone foliation (S_2). The latter is inclined to the shear zone boundaries by a little less that 45° in the margins of the zones and is approximately parallel to the zones in their centres. (b) Complex zones with sinistral horizontal separation, dextral "drag" and a strongly folded S_2. The axial planes of the folds are approximately parallel to the zone boundaries and the folds plunge parallel to the stretching lineation. There is no evidence of sheath folding. Where a dolerite dyke occurs in a simple shear zone it is undeformed, but where the dykes occur in the complex zones they are deformed.

The northeasterly trending shear zones are approximately parallel to the general trend of S_1 and perpendicular to the dolerite dykes. The dykes are consistently offset dextrally. Where the shear zones are inclined to S_1 the horizontal separation of marker layers is mostly sinistral but may be dextral. There is no consistent "drag" associated with these zones and S_2 is approximately parallel to the zone boundaries.

All of the data can be expained in terms of the following history: First a conjugate pair of transcurrent shear zones developed in response to horizontal minimum and maximum compressive directions with the maximum direction trending north/south. This caused the dextral "drag" and displacement on the northwest trending zones and the sinistral displacement on the northeast trending zones. The maximum compressive direction then rotated to approximately northwest and the dolerite dykes were emplaced. At this time the minimum compression was probably still horizontal. Then the maximum compressive axis rotated to a westerly direction and mimimum axis switched to a vertical orientation. The existing shear zones, behaving as zones of weakness, were reactivated and accommodated the east-west shortening and vertical extension was accommodated by slip on S_1. Consequently the shear zones behaved as transpressive stretching faults with shear zone-parallel extension occuring vertically. The reactivation reversed the sense of movement on the shear and in many the net result is the opposite sense of displacement to that of the original movement.

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CONGRÈS DU CTG 1991

LIVRET-GUIDE D'EXCURSION

INTRODUCTION

Les Appalaches du Québec chevauchent les zones d'Humber et de Dunnage (figure 1). La limite entre ces deux zones correspond à la ligne Brompton-Baie Verte (BBL). Il s'agit d'une zone de faille marquée par un alignement de complexes ophiolitiques et de lentilles ultramafiques serpentinisées mis en place tectoniquement à l'Ordovicien et subséquemment affectés par l'orogégèse acadienne (Williams & St-Julien, 1982). À l'échelle régionale, le contraste de style tectonique entre les zones d'Humber et de Dunnage rappelle les structures triangulaires des Cordillières.

Dans la zone de Dunnage, la déformation régionale acadienne D2 a produit une schistosité pénétrative S2 dans les siltstones et les mudslates et un clivage de fracture dans les grès. L'attitude de cette schistosité régionale tend à se paralléliser avec les zones de faille majeures telles la BBL et la faille de la Guadeloupe, ce qui provoque un changement systématique et graduel d'attitude du nord vers le NE. Une déformation précoce D1 affecte les terrains cambro-ordoviciens du Complexe de St-Daniel et les grès de la colline Bunker exposés à l'est du Lac Memphrémagog. Finalement, un clivage de crénulation tardif S3 orienté ENE affecte peu les structures préexistantes.

Le motif de déformation de la zone d'Humber, très différent de celui de la zone de Dunnage, est typique d'une tectonique superposée produite au faciès métamorphique des schistes verts. On considère généralement que les structures de la zone d'Humber sont ordoviciennes car elles apparaissent uniquement dans les unités cambro-ordoviciennes. La déformation précoce D1 a produit des plissements isoclinaux et des failles qui pourraient être associées à un transport tectonique vers le NO. L'attitude de la schistosité régionale S2 et la vergence des plis P2 indiquent un rétrocharriage vers le SE, particulièrement évident dans le Groupe d'Oak Hill de la région de Richmond (Marquis, 1989). Dans la région d'Orford, le plus bel exemple de rétrocharriage est sans doute la zone de faille de Stukely qui juxtapose des unités démembrées du Groupe d'Oak Hill et la Suite métamorphique de Sutton (Brodeur et Marquis 1991).

La déformation D3 produit une antiforme de schistosité, l'anticlinorium des monts Sutton, à laquelle est associé un clivage de crénulation S3 disposé en éventail. Ce plissement ouvert, faiblement plongeant et d'envergure régionale pourrait être un "fault related fold" (Suppe, 1987, Marquis 1989, Colpron 1990) formé au-dessus

CTG ANNUAL MEETING 1991

FIELD GUIDE

INTRODUCTION

The Quebec Appalachians straddle the Humber and Dunnage zones (figure 1). The limit between those two zones is the Brompton-Baie Verte line (BBL), delineated by an alignment of ophiolitic complexes and serpentinized ultramafic rocks. Tectonically emplaced during Ordovician times, the BBL was reactivated later during the Acadian orogeny (Williams & St-Julien, 1982). On the regional scale, the contrast in structural style between the Humber and Dunnage zones could be an analogue to the Cordillian triangular structure.

The Dunnage zone regional deformation D2 is of Acadian age. S2 is a penetrative schistosity in siltstones and mudstones and a fracture cleavage in sandstones. S2 changes strike systematically and gradually from north to NE. It tends to be almost parallel to major fault zones, the BBL in the Orford area and the NE stricking La Guadeloupe fault east of Lake Memphremagog. An early deformation D1 is known to affect the Cambro-Ordovician rocks of the St-Daniel Complex, and the Bunker Hill sandstones which are exposed east of Lake Memphremagog. A late ENE crenulation cleavage S3 does not reorient fabrics.

The Humber zone style of deformation, very different from that of the Dunnage zone, is typical of polyphased greenschist metamorphic grade tectonic domains. The age of the Humber zone deformation is considered to be Ordovician based on the observation that only Cambro-Ordovician rocks are affected by it.

The earlier deformation D1 produced isoclinal folds and faults which can be related to a NW tectonic displacement. Since the regional schistosity S2 dips to the NW and since F2 folds, well exposed to the north in the Richmond area, have a vergence toward the SE, D2 is considered backthrusting. In the Orford area the best example of backthrusting during D2 is along the Stukely Fault Zone which juxtaposes dismembered units of the Oak Hill Group and the Sutton Metamorphic Suite (Brodeur et Marquis, 1991).

A late deformation D3 is responsible for the Sutton Mountain Anticlinorium, a schistosity antiform associated with a fanning crenulation cleavage S3. This open, shallowly plunging, regional fold patterm is interpreted as a fault related fold (Supper 1987, Marquis 1989, Colpron 1990) over a deeply buried ramp. The latest cleavage S4 is oriented ENE. Mapped in the Sutton Suite in proximity to the BBL, this cleavage, the youngest of the Humber zone, could be contemporaneous with an Acadian sinistral strike slip along the Orford segment of the BBL, as suggested by a satellite lineament interpretation (figure 2).

Finally, a brittle extensive deformation related to the opening of the Atlantic Ocean made possible the emplacement of Cretaceous lamprophyres,porphyritic syenite dykes and a diatreme breccia which penetrate previous structures.

The Saturday field trip (figure 3, stops 1 to 5) is along the BBL and the adjacent Dunnage zone. We will be focusing on the lenticular aspect of the

d'une rampe enfouie. Un clivage tardif S4 orienté ENE est également reconnu dans la Suite de Sutton près de la BBL. Ce clivage, le plus jeune de la zone d'Humber, pourrait être acadien et associé à un décrochement senestre suggéré par une interprétation de linéaments satellites du segment d'Orford de la BBL (figure 2). Finalement, une déformation cassante extensive associée à l'ouverture de l'océan Atlantique a permis la mise en place de lamprophyres, de dykes de syénite porphyrique et d'une brèche de diatrème Crétacé qui recoupent toutes les structures antérieures.

L'excursion de samedi (figure 3, arrêts 1 à 5) concerne la ligne Brompton-Baie Verte et la zone de Dunnage. Nous mettrons l'accent sur l'aspect lenticulaire des unités lithologiques et sur la nature des contacts. L'excursion se terminera au ruisseau Castle où les métasédiments d'avant-arc du Groupe de Magog apparaissent sur les dépôts chaotiques du Complexe structural de St-Daniel.

L'excursion du dimanche (figure 3, arrêts 6 à 8) porte sur la zone d'Humber. Nous verrons les schistes très déformés de la Suite de Sutton, et leur relation avec les unités adjacentes moins déformées du Groupe d'Oak Hill et du Complexe de Mansville. Nous examinerons également les amygdales déformées d'un métabasalte du Groupe d'Oak Hill. Le sens du déplacement indiqué par ces marqueurs cinématiques n'est pas clair.

EXCURSION DU SAMEDI, 19 OCTOBRE

La zone de Dunnage et la ligne Brompton-Baie Verte

Arrêt 1 : La BBL à Eastman

Cet arrêt se trouve à la sortie 106 de l'autoroute 10 sur la bretelle sud de l'autoroute. Les lithologies sont variées : phyllade, grès, métabasalte aux coussinets aplatis et serpentinite cisaillée. On pourra discuter des résultats obtenus par une méthode d'étude cinématique des failles (Angelier, 1979) (figure 4).

Arrêt 2 : Métagrès de la zone de Dunnage

Cet arrêt se trouve le long de la route 112 en allant vers le lac Orford, à 2,65 km d'Eastman face au chemin du Bosquet. Exemple de déformation intense dans un métagrès à quartz, chlorite, mica blanc probablement dérivé de la Suite de Sutton et incorporé tectoniquement au Complexe de St-Daniel. Le lien entre les éléments structuraux des arrêts 1 et 2 est obscur.

various lithologic units and on the type of contacts. The last stop of the field trip will be at Castle Brook where forearc metasedimentary rocks of the Magog Group overlie chaotic deposits of the St-Daniel Structural Complex.

The Sunday field trip (figure 3, stops 6 to 8) will be in the Humber zone. We will see highly deformed mica schist of the Sutton Suite and their relationship with adjacent less deformed units of the Oak Hill Group and the Mansville Complex. We will examine deformed amygdules from a metabasalt characteristic of the oldest unit of the Oak Hill Group. The sense of shearing shown by these kinematic indicators is obscure.

SATURDAY FIELD TRIP, OCTOBER 19

The Dunnage zone and the Brompton-Baie Verte line.

Stop 1 : The BBL in Eastman

This stop is located at exit 106, on the southern side of autoroute 10. Lithologies vary from phyllite, sandstone, flattened pillowed metabasalt and sheared serpentinite. We will discuss results obtained using the Angelier (1979) method for the kinematic study of fault striae (figure 4).

Stop 2 : Metasandstone of the Dunnage zone

This stop is along route 112 going east toward Orford Lake, 2.65 km from Eastman in front of the "chemin du Bosquet". At this locality we will see an example of intense deformation of a quartz, chlorite, white mica metasandstone, probably derived from the Sutton Suite, and tectonically incorporated into the St-Daniel Complex. The link between structural elements of stops 1 and 2 is obscure.

Stop 3 : Sandstone and slate assemblage of the Dunnage zone

This stop is along route 112, close to Orford Lake, 4.25 km from Eastman. Note the little deformed graded bedding in the sandstone and dark grey slate,which are unfossiliferous turbidites of probable Cambrian age, deposited on the Iapetus continental slope. A serpentinite sliver crops out in a meter wide fault zone.

Stop 4 : Basal sole thrust of the Orford Ophiolitic Complex

This stop is in front of Orford Lake rest area 4.75 km from Eastman. A classic ophiolitic mélange with a serpentinite matrix containing little deformed peridotite fragments (cm to m thick) exhibits a phacoidal schistosity. A light coloured rodingite also crops out. Note the diffuse contact with the ophiolitic mélange. Numerous striated fault planes are suitable for a kinematic analysis using the Angelier (1979) method.

Arrêt 3 : Grès et shale de la zone de Dunnage

Cet arrêt se trouve le long de la route 112 en s'approchant du Lac Orford, à 4,25 km d'Eastman. Il s'agit de grès granoclassé et de shale gris foncé, des turbidites non fossilifères, probablement d'âge Cambrien, accumulées sur le talus continental d'Iapétus. Un copeau de serpentinite apparaît dans une zone de faille, d'épaisseur métrique.

Arrêt 4 : Semelle du Complexe ophiolitique d'Orford (COO)

Cet arrêt se trouve face à la halte routière du Lac Orford à 4,75 km d'Eastman. Bel exemple de mélange ophiolitique classique avec schistosité phacoïdale dans la matrice serpentinisée qui entoure des blocs de péridotite peu déformés, décimétriques à décamétriques. Un granite rodingitisé affleure également. Notez le contact diffus avec le mélange ophiolitique. De nombreuses failles striées couvertes de picrolite, pourraient être analysées selon la technique d'Angelier (1979).

Arrêt 5 : Prisme d'accrétion et bassin avant-arc

Cet arrêt se trouve au ruisseau Castle à l'est du pont situé sur le chemin des Pères à 1,5 km de l'intersection avec la route 112. Cet affleurement montre le contact entre les dépôts chaotiques de prisme d'accrétion du Complexe de St-Daniel et les métasédiments de bassin avant-arc du Groupe de Magog datés à l'Ordovicien moyen (Caradoc). S'agit-il d'une discordance? C'est aussi une localité fossilifère à Climacograptus Caudatus (Ruedemann, 1947). Les graptolites parfois pyritisés sont très étirés. Ils apparaissent dans un shale noir plissé, connu pour son potentiel concernant la formation de gisements du sulfures massifs de type SEDEX (Gauthier et al., 1989).

Stop 5 : Accretionary prism and forearc basin

This stop is along Castle Brook, east of the bridge on the "chemin des Pères", 1.5 km from the intersection with route 112. This outcrop contains the contact between chaotic accretionary prism deposits of the St-Daniel Complex and layered forearc type metasediments of the Middle Ordovician (Caradocian) Magog Group. Is this contact an unconformity? This stop is also a fossiliferous locality (Climacograptus Caudatus, Ruedemann, 1947). Occasionaly pyritised, the graptolites are always highly stretched. They are concentrated within a black slate unit which is also known for its SEDEX type massive sulfide potential (Gauthier et al., 1989).

SUNDAY FIELD TRIP, OCTOBER 20

The Humber zone : Polyphased deformation and backthrusting

Stop 6 : Sutton Metamorphic Suite

This stop is located at km 104 along autoroute 10. The various schists of the Sutton Metamorphic Suite were probably emplaced during the Late Precambrian-Early Cambrian initial phase of Iapetus rifting. During subduction of Iapetus, these deposits were incorporated into an accretionary prism, so these rocks are more highly deformed and metamorphosed than adjacent units (Colpron, 1990). This outcrop exhibits different lithologies of the Sutton Suite as well as structural elements associated with the main deformation episodes (figure 5). At the western end of the outcrop the Cretaceous Eastman diatreme breccia is exposed.

Stop 7 : Kinematic markers of the Oak Hill Group metabasalt

This stop is located at exit 90, on the northern side of autoroute 10. There crops out a chlorite, epidote, amygdule bearing metabasalt emplaced during the rifting stage of Iapetus, 554 Ma ago (Kumarapeli, 1989). A blue phyllite of sedimentary origin marks the limit between two lava flows. The quartz and feldspar amygdules are potentially good kinematic indicators but the sense of tectonic transport contemporaneous with the regional schistosity S2 is not evident.

Stop 8 : Stukely Fault Zone

This stop is north of South Stukely, 1 km from the intersection of route 112 and "le chemin des Carrières". The Stukely fault zone is a major D2 backthrust marking the western limit of the Sutton Metamorphic Suite (Brodeur et Marquis, 1991). At this stop, we can observe the contacts between a metabasalt, a marble and a black schist. The geochemical signature of the metabasalt is typical of the Oak Hill Group (figure 6). The marble could be derived from a Cambrian reef. The black chlorite, graphite schist is a metapelite of the Sutton Metamorphic Suite.

EXCURSION DU DIMANCHE, 20 OCTOBRE

La zone d'Humber : déformation superposée et rétrocharriage.

Arrêt 6 : Suite métamorphique de Sutton

Cet arrêt se trouve le long de l'autoroute 10, à la borne kilométrique 104. Les schistes de la Suite métamorphique de Sutton pourraient provenir de dépôts mis en place durant la phase initiale de rift d'Iapétus au Cambrien ancien. Durant la phase de fermeture d'Iapétus ces dépôts auraient été incorporés au prisme d'accrétion, ce qui explique qu'ils soient plus déformés et plus métamorphisés que les unités limitrophes (Colpron, 1990). Cet affleurement montre différentes lithologies de la Suite de Sutton de même que les éléments structuraux des principales phases de déformation (figure 5). À l'extrémité ouest de l'affleurement est exposée la brèche de diatrème d'Eastman, d'âge Crétacé.

Arrêt 7 : Marqueurs cinématiques dans un métabasalte du Groupe d'Oak Hill

Cet arrêt se trouve le long de la bretelle nord de l'autoroute 10 à la sortie 90 vers Waterloo. Cet affleurement expose surtout un métabasalte à chlorite et à épidote (figure 6), amydgalaire, mis en place durant la phase de rifting d'Iapétus il y a environ 554 Ma (Kumarapeli, 1989). Une phyllade bleutée d'origine sédimentaire marque la limite entre deux coulées de lave. Les amygdales remplis de quartz et de feldspath sont de bons marqueurs cinématiques potentiels mais le sens du transport tectonique contemporain de la schistosité régionale S2 ne nous apparaît pas évident.

Arrêt 8 : Zone de faille de Stukely

Cet arrêt se trouve au nord du village de Stukely-sud à 1 km de l'intersection entre le chemin des Carrières et la route 112. Il s'agit de la zone de faille de Stukely, une structure majeure reliée à un rétrocharriage vers le SE qui marque la limite ouest de la Suite de Sutton (Brodeur et Marquis, 1991). On y observe les contacts entre un métabasalte, un marbre et un schiste noir. La composition géochimique du métabasalte est typique du Groupe d'Oak Hill (figure 6). Le marbre pourrait être dérivé d'un récif Cambrien. Le schiste noir à chlorite, graphite est une métapélite de la Suite métamorphique de Sutton.

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LISTE DES FIGURES / *FIGURE CAPTIONS*

Figure 1 : Les Appalaches du Québec en Estrie-Beauce / *Quebec Appalachians in the Eastern Townships.* (Carte géologique routière du sud-est du Québec, ACDE, 1991, échelle approximative au 1 : 1 250 000).

Figure 2 : Interprétation de linéaments satellites le long du segment d'Orford de la ligne Brompton-Baie Verte/ *Remote sensing lineament interpretation along the Orford segment of the BBL. (Brodeur et Marquis, 1991).*

Figure 3 : Arrêts 1 à 8 / *Stops 1 to 8*

a) Carte géologique de la région d'Orford, Québec et localisation des arrêts / *Geological map of the Orford area, Quebec showing stops location.*
b) Coupe AA' illustrant le style tectonique ,régional / *Regional tectonic style along cross section AA' (modified from Brodeur et Marquis, 1991).*

Figure 4 : Arrêt 1 / *Stop 1*

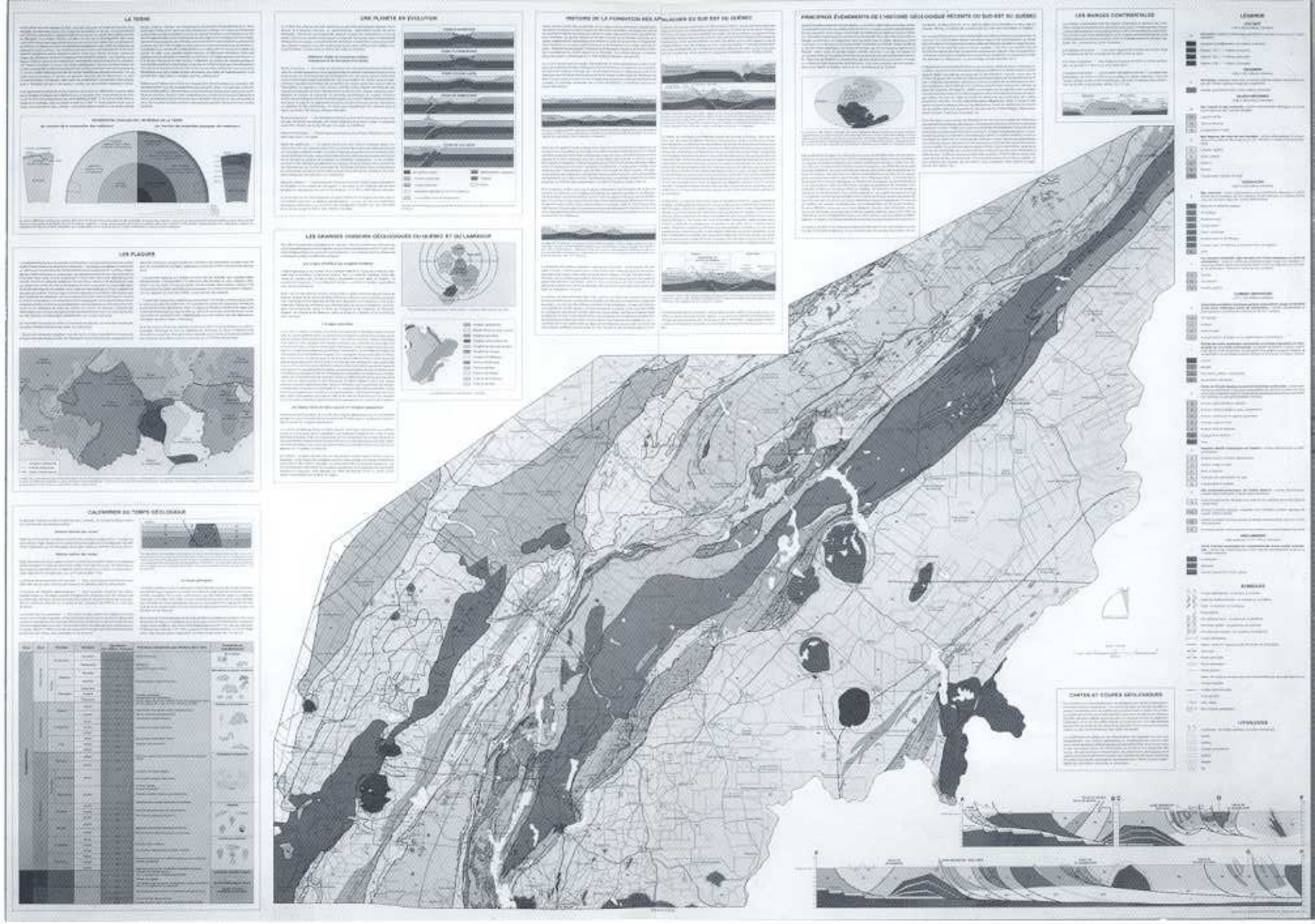
Étude cinématique le long de la BBL. Application de la méthode d'Angelier (1979) / *Kinematic interpretation along the BBL using Angelier (1979) method (Brodeur, Faure, Marquis, 1991).*

Figure 5 : Arrêts 1 à 4 et 6 à 8 / *Stops 1 to 4 and 6 to 8*

a) Les domaines structuraux de la région d'Orford / *Structural domains in the Orford area*
b) Stéréogramme πS2 des domaines 2 et 3 / *Domains 2 and 3 πS2 stereonet*
c) Attitude moyenne des éléments structuraux pour chacun des domaines / *Structural elements mean attitude for each domain (Brodeur et Marquis, 1991).*

Figure 6 : Arrêts 7 et 8 / *Stops 7 and 8*

Analyse géochimique comparative des métabasaltes de la Suite métamorphique de Sutton, du Groupe d'Oak Hill et de la zone de faille de Stukely / *Comparative geochemical analysis of metabasalts from the Sutton metamorphic Suite, Oak Hill Group, and Stukely fault zone (Brodeur et Marquis, 1991).*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LES MARGES CONTINENTALES
LÉGENDE
LES PLAQUES
LES GRANDES ÉPOQUES GÉOLOGIQUES DU QUÉBEC ET DU LABRADOR
CALENDRIER DU TEMPS GÉOLOGIQUE
CARTES ET COUPES GÉOLOGIQUES

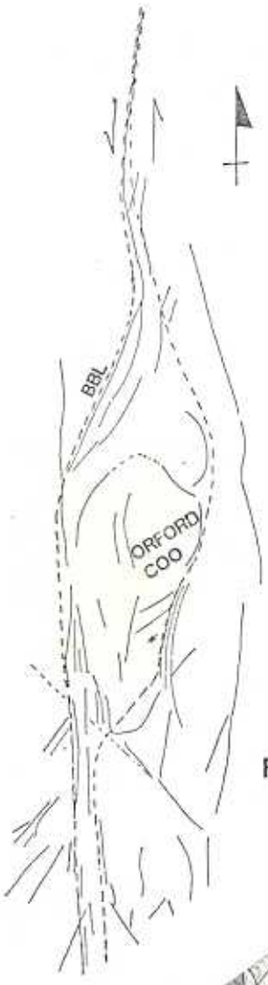


Figure 2

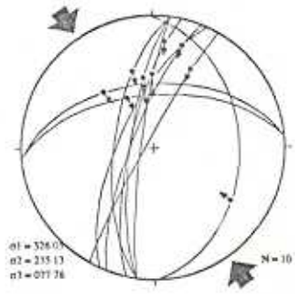
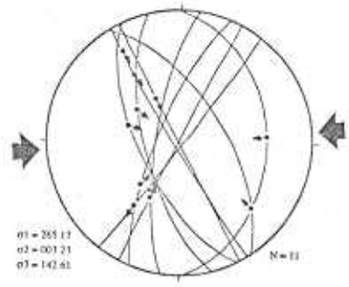


Figure 4.1



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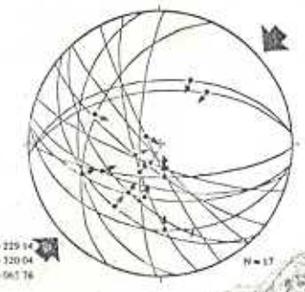


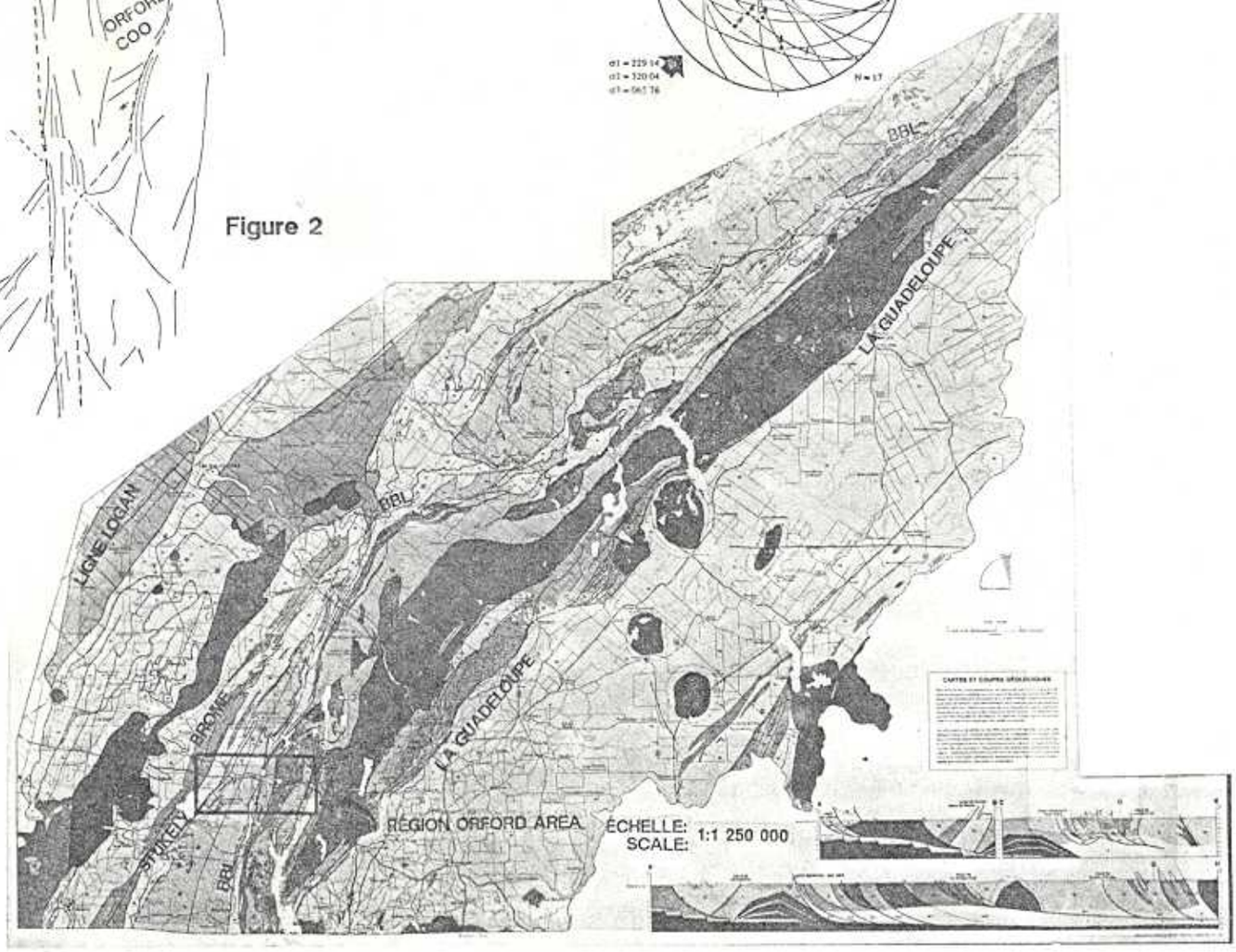
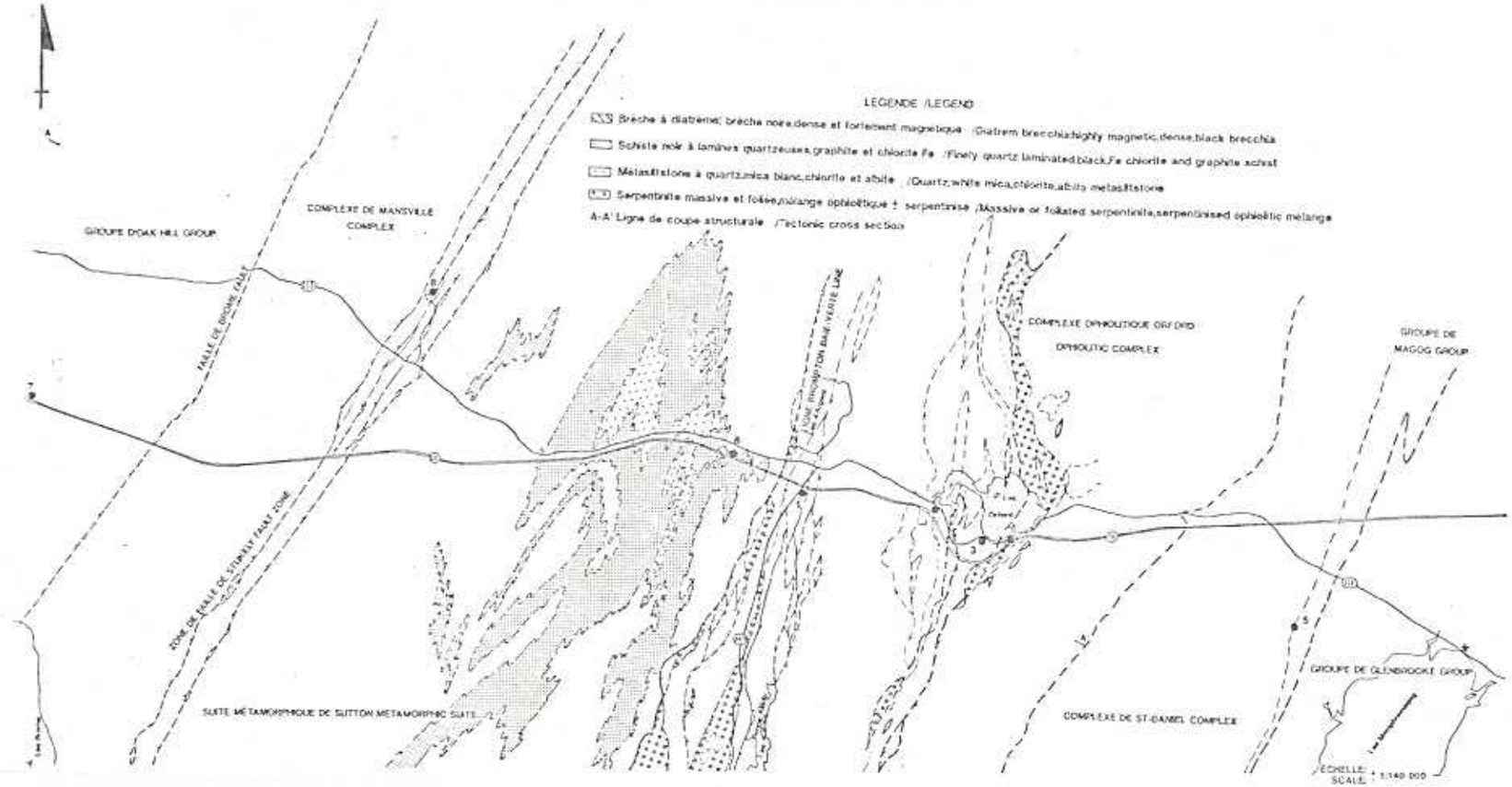


Figure 1


LEGENDE /LEGEND
Brèche à diabèse; brèche noire,dense et fortement magnétique /Diabase breccia;highly magnetic,dense,black breccia
Schiste noir à lamines quartzeuses,graphite et chlorite Fe /Finely quartz laminated black,Fe chlorite and graphite schist
Métaséditstone à quartz,mica blanc,chlorite et albite /Quartz,white mica,chlorite,albite metasiltstone
Serpentinite massive et foliée,mélange ophiolitique ± serpentinisé /Massive or foliated serpentinite,serpentinised ophiolitic mélange
A-A' Ligne de coupe structurale /Tectonic cross section
GROUPE D'OAK HILL GROUP
COMPLEXE DE MANSVILLE COMPLEX
FAILLE DE BROME FAULT
ZONE DE FAILLE DE STANSTEAD FAULT ZONE
SUITE MÉTAMORPHIQUE DE SUTTON METAMORPHIC SUITE
COMPLEXE OPHIOLITIQUE ORFORD
OPHIOLITIC COMPLEX
GROUPE DE MAGOG GROUP
GROUPE DE GLENBROOKE GROUP
COMPLEXE DE ST-DANIEL COMPLEX
ÉCHELLE: SCALE: 1:140 000

a)

b)

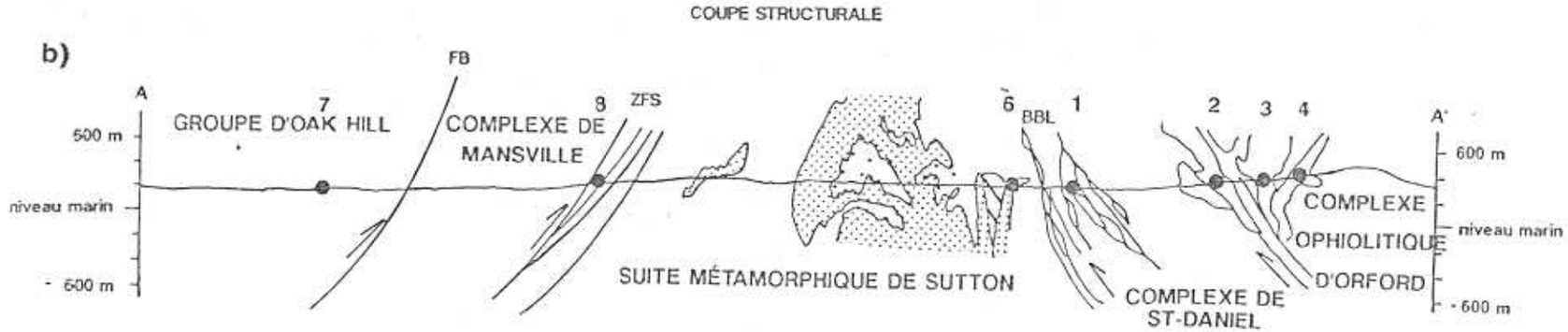
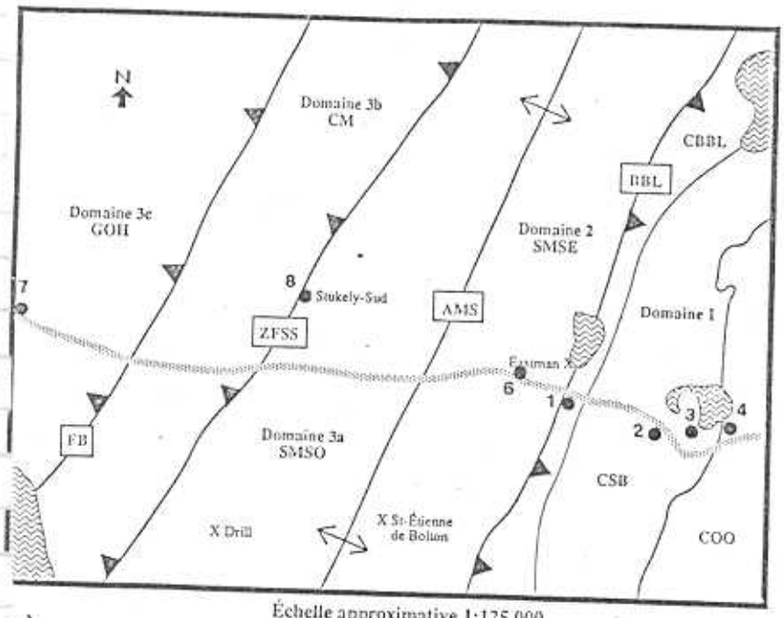
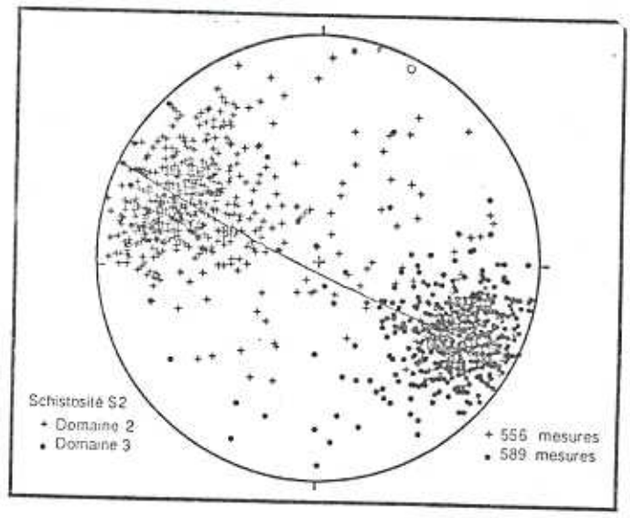

COUPE STRUCTURALE
A
A'
600 m
niveau marin
- 600 m
GROUPE D'OAK HILL
7
FB
COMPLEXE DE MANSVILLE
8
ZFS
6
BBL
1
2
3
4
SUITE MÉTAMORPHIQUE DE SUTTON
COMPLEXE DE ST-DANIEL
COMPLEXE OPHIOLITIQUE D'ORFORD

Figure 3



Échelle approximative 1:125 000

a)



b)

c)

D	S2	S3	AP2	AP3	δ2/δ-1	δ3/2	Lin min
2	020 72	022 88	129 70	025 04	***	195 08	113 62
3a	207 63	016 86	265 64	023 04	285 64	019 16	297 64
3b	206 65	020 80	249 66	022 05	***	022 08	286 57
3c	205 61	019 87	253 71	***	***	209 09	***

D	Sn-1	Sn	Sn+1	δn-1/δ	δn/δ-(n-1)	δn+1/n
1	005 77	005 77	230 03	041 51	024 44	074 79

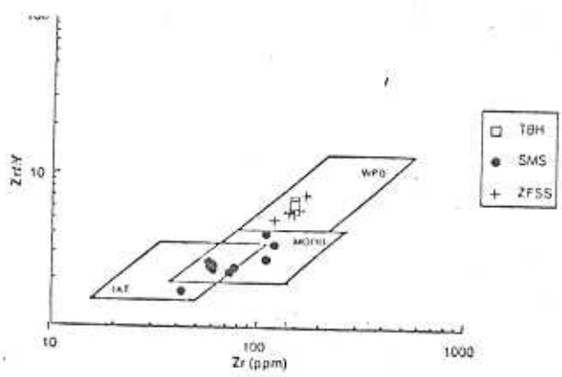
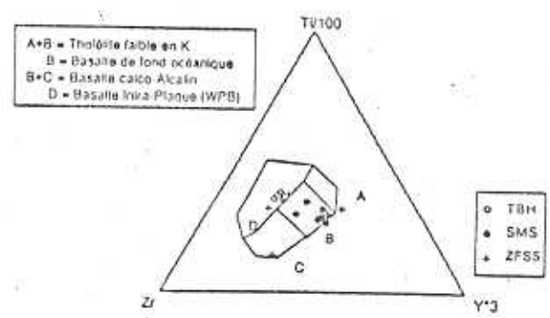
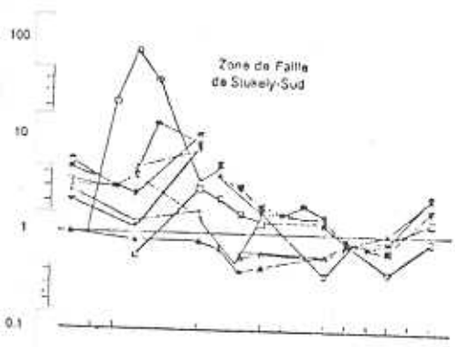
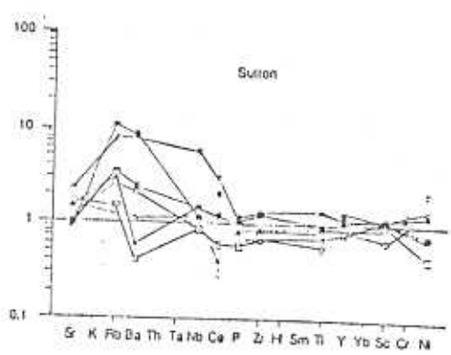
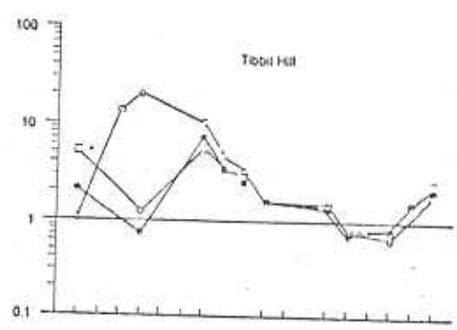



Figure 5