Northeastern Section - 43rd Annual Meeting (27-29 March 2008)

Paper No. 20-1

Presentation Time: 8:05 AM-8:25 AM

FORELAND ZONE FAULTS AND VEINS RELATED TO ALONG-STRIKE PROPAGATION OF SLAB BREAKOFF AT THE END OF THE TACONIC OROGENY

LIM, Chul and **KIDD, William S.F.**, Dept of Earth and Atmospheric Sciences, University at Albany, 1400 Washington Ave, Albany, NY 12222-0100, wkidd@atmos.albany.edu

The breakoff of a subducted slab removes downward slab pull to switch the compressional stress in a collision zone to tensional stress, resulting in the collisional shortening structures being cut by strike-parallel normal faults. In the Taconic frontal zone we identify major normal faults truncating shortening structures. High-angle normal faults observed at Bald Mountain, in Troy and near Hudson in eastern New York suggests that a substantial part of the present western boundary of the Taconic Allochthon is marked by an east-side-down normal fault system, and this extensional event also includes the Mettawee Fault, which truncates the Champlain Thrust. This regional extension is constrained in the Albany area to have occurred immediately following the latest thrusting during the Caradocian, and before the latest Silurian; we propose it was caused by subducted slab breakoff. The previously documented reversal of Taconic subduction polarity provides a tectonic framework that requires slab breakoff. A conspicuous development of planar reverse-motion veins in the Taconic melange marks brittle deformation of the melange zones at the end of the Taconic shortening; we propose that these veins were caused by an enhanced "marginal" slab pull (from the dangling part of the slab), during northward propagation of slab breakoff. The strike-slip cross faults/veins occurring commonly at the margin of and in the foreland of the Taconic orogen in New York and Vermont can also be explained by accommodation of differential strains caused by migration of the marginal slab pull and the breakoff point. Propagation of the slab breakoff toward north during the cessation of Taconic convergence is supported by evidence of oblique collision of the Laurentian margin and progressively later occurrence of the last shortening events in the same direction.

Northeastern Section - 43rd Annual Meeting (27-29 March 2008)
General Information for this Meeting

Session No. 20--Booth# 0
Evolution of the Taconian Foreland Basin: Timing of Late Ordovician Sedimentological and Tectonic Events as Seen From Outcrop and Subsurface Sources I
Hyatt Regency Buffalo: Regency Ballroom
8:00 AM-10:45 AM, Friday, 28 March 2008

© Copyright 2008 The Geological Society of America (GSA), all rights reserved. Permission is hereby granted to the author(s) of this abstract to reproduce and distribute it freely, for noncommercial purposes. Permission is hereby granted to any individual scientist to download a single copy of this electronic file and reproduce up to 20 paper copies for noncommercial purposes advancing science and education, including classroom use, providing all reproductions include the complete content shown here, including the author information. All other forms of reproduction and/or transmittal are prohibited without written permission from GSA Copyright Permissions.

19-2 **8:40 AM** Hooks, Benjamin P.

RHEOLOGICAL CONTROLS ON THE FOCUSING OF DEFORMATION IN ACTIVE OROGENS

HOOKS, Benjamin P.[1], KOONS, Peter O.[1], JOHNSON, Scott[1], UPTON, Phaedra[2], GERBI, Christopher[1], and PAVLIS, Terry[3], (1) Department of Earth Sciences, University of Maine, Orono, ME 04469, benjamin.hooks@umit.maine.edu, (2) Geology Department, University of Otago, Dunedin, New Zealand, (3) Department of Geological Sciences, UTEP, El Paso, TX 79902

Alaska has been formed through the collision and accretion of numerous terranes onto its southern margin. The currently active oblique collision of the Yakutat terrane, an oceanic plateau, with southeastern Alaska has uplifted the highest coastal ranges on Earth; the St. Elias Mountains. This terrane accretion has created an incipient plate corner tectonic aneurysm, similar to the Himalayan Eastern Syntaxis (Tsang Po- Namche Barwa region). The tectonic aneurysm forms as a weak region within an active orogen where non-linear coupling between deformation and erosion focuses horizontal and vertical strain into the most rapidly eroding region. Signatures of a tectonic aneurysm may include areas of abnormally high heat flow, extraordinary uplift rates, high erosion rates, and steep gradients in topography. In the geologic record, tectonic aneurysms may be recognized by isolated zones of relatively higher metamorphic grade, such as gneiss domes.

Additional rheological non-linearities relevant to geological evolution of terrane accretion arise through mechanisms of strain softening that significantly alter both outcrop and finite strain patterns. The combination of oblique collision and strain-dependent crustal rheology conspire to develop weakened areas that are prone to further focused weakening and deformation. During terrane accretion, these weakened areas step discontinuously through the orogen such that deformation across the area is asynchronous.

The Appalachian Mountains have evolved through a series of terrane accretion events for which the current Yakutat terrane accretion may be used as a modern analog. The Acadian-aged rocks in Maine record a period of dextral transpression that was most clearly recorded within the Norumbega Fault System during the Middle Devonian. The nature of transition of lateral to convergent strain identified in 3D numerical models of Yakutat accretion provides a strain template that can aid in deciphering the local kinematics of the Acadian Orogen.

19-3 **9:00 AM** Johnson, Scott E.

RHEOLOGICAL HETEROGENEITY AND THE STATE OF STRESS IN THE ROOTS OF A LARGE-DISPLACEMENT, STRIKE-SLIP, SEISMOGENIC FAULT: THE NORUMBEGA FAULT SYSTEM IN MAINE

JOHNSON, Scott E.[1], KOONS, Peter[1], WEST, David P. Jr[2], and PRICE, Nancy[1], (1) Department of Earth Sciences, University of Maine, 5790 Bryand Global Sciences, Orono, ME 04469, johnsons@maine.edu, (2) Geology Dept, Middlebury College, Middlebury, VT 05753

There are currently no direct data on the state of stress 15-20 km below vertical, large-displacement, strike-slip, seismogenic faults like the San Andreas Fault in California. Yet, it is clear from theoretical and numerical studies that the state of stress on such faults is significantly influenced by the state of stress in underlying mylonitic shear zones at depths corresponding to the frictional-to-viscous transition (FVT). Although we must reach a better understanding of the state of stress at the FVT below these faults, the difficulty lies in locating a suitable exhumed fault system. To provide relatively tight constraints on the stress tensor, the chosen field locality should contain irrefutable evidence for coseismic rupture (pseudotachylyte), and be characterized by: (a) tightly constrained kinematic boundary conditions, (b) microstructures amenable to estimates of differential stress and mean kinematic vorticity, and (c) lithological (rheological) heterogeneity providing natural variability in the stress and vorticity estimates. In such a system, 3D numerical experiments can arrive at best-fit solutions for the field-derived stress and vorticity estimates, and in doing so solve for the principal and Cartesian stresses.

One of the very few field occurrences that meet the above criteria is the Norumbega Fault System (NFS), northeastern Appalachians. The NFS represents the roots of a long-lived, Paleozoic, right-lateral, large-displacement, subvertical, strike-slip fault system. The Sandhill Corner mylonite zone (SCMZ) is the largest, most continuous mylonitic strand of the NFS, forming an impressive zone of mutually overprinting mylonite and pseudotachylyte up to 300 m wide. A portion of the SCMZ developed along a lithologic contact between quartzofeldspathic and mica-rock metasedimentary rocks. Owing to the unique exposures, we are able to measure differential stress and mean kinematic vorticity number using both optical and electron-beam techniques. These field-derived data, combined with the approximately monoclinic strain symmetry of the SCMZ, are used to constrain 3D numerical experiments that solve for the principal and Cartesian stresses. These results at depth are used as input for 3D numerical models of the upper 30 km of Earth, allowing us to explore the effects of kinematic and dynamic states at depth on active seismogenic faults above.

19-4 **9:20 AM** Cruden, Alexander

DEFORMATION LOCALIZATION DURING SHORTENING OF HETEROGENEOUS CRUST

CRUDEN, Alexander[1], SCHRANK, Christoph[1], and RILLER, Ulrich[2], (1) Dept. of Geology, University of Toronto, 22 Russell St, Toronto, ON M5S 3B1, Canada, cruden@geology.utoronto.ca, (2) Museum for Natural History, Humboldt University, Invalidenstrasse 43, Berlin, 10115, Germany

Orogens are characterized by the presence of large scale heterogeneities such as granitic plutons, lateral changes in sedimentary or tectonic cover sequence thickness, and in special cases spatial variation in upper crustal thickness due to impact cratering processes. We report on 3D isothermal scaled analogue experiments and 2D numerical experiments that explore the behavior of individual competent tabular plutons, spatially distributed intrusions, and upper crustal lateral (orogen parallel) and localized (i.e., impact structures) thickness variations. These heterogeneities are incorporated in rheologically layered crust (frictional/brittle over ductile/viscous) subjected to regional shortening. Individual tabular plutons respond to shortening by developing domal antiforms whose wavelength and amplitude are controlled by density and viscosity contrasts with the host material, with strain localization occuring on dome boundaries. Spatially distributed tabular intrusions control the location of major doubly plunging antiforms and shorter wavelength synforms in the intervening crust. Strain accumulation on pluton margins leads to localization of thrusts that eventually link to form orogen subparallel curvilinear transpression zones. Both the style of folding and the shear zone distribution are geometrically similar to structural patterns in Archean granite-greenstone belts. Shortening of crust with orogen-parallel variation in brittle sedimentary cover thickness results in rhomb-shaped deformation domains whose boundaries consist of an anastomosing network of kinematically coupled, sinistral and dextral transpressive deformation zones. A similar segmentation of the upper crust into rhomb-shaped deformation domains, often forming sedimentary basins, is a ubiquitous characteristic of wide orogenic belts, notably the central Andes and Tibet. Shortening of crust containing a large, circular impact structure excavated to mid-crustal levels results in the development of an asymmetric doubly plunging basin with a reverse fault nucleated on the steep flank. The result is geometrically similar to the post-impact deformation of the Sudbury impact structure and the surrounding Huronian cover and Archean basement.

SESSION NO. 20, 8:00 AM

Friday, 28 March 2008

T6. Evolution of the Taconian Foreland Basin: Timing of Late Ordovician Sedimentological and Tectonic Events as Seen From Outcrop and Subsurface Sources I (*Eastern Section of the Society for Sedimentary Geology (SEPM)*)

Hyatt Regency Buffalo, Regency Ballroom

20-1 **8:05 AM** Kidd, William S.F.

FORELAND ZONE FAULTS AND VEINS RELATED TO ALONG-STRIKE PROPAGATION OF SLAB BREAKOFF AT THE END OF THE TACONIC OROGENY

LIM, Chul and KIDD, William S.F., Dept of Earth and Atmospheric Sciences, University at Albany, 1400 Washington Ave, Albany, NY 12222-0100, wkidd@atmos.albany.edu

The breakoff of a subducted slab removes downward slab pull to switch the compressional stress in a collision zone to tensional stress, resulting in the collisional shortening structures being cut by strike-parallel normal faults. In the Taconic frontal zone we identify major normal faults truncating shortening structures. High-angle normal faults observed at Bald Mountain, in Troy and near Hudson in eastern New York suggests that a substantial part of the present western boundary of the Taconic Allochthon is marked by an east-side-down normal fault system, and this extensional event also includes the Mettawee Fault, which truncates the Champlain Thrust. This regional extension is constrained in the Albany area to have occurred immediately following the latest thrusting during the Caradocian, and before the latest Silurian; we propose it was caused by subducted slab breakoff. The previously documented reversal of Taconic subduction polarity provides a tectonic framework that requires slab breakoff. A conspicuous development of planar reverse-motion veins in the Taconic melange marks brittle deformation of the melange zones at the end of the Taconic shortening; we propose that these veins were caused by an enhanced "marginal" slab pull (from the dangling part of the slab), during northward propagation of slab breakoff. The strike-slip cross faults/veins occurring commonly at the margin of and in the foreland of the Taconic orogen in New York and Vermont can also be explained by accommodation of differential strains caused by migration of the marginal slab pull and the breakoff point. Propagation of the slab breakoff toward north during the cessation of Taconic convergence is supported by evidence of oblique collision of the Laurentian margin and progressively later occurrence of the last shortening events in the same direction.

20-2 **8:25 AM** Waldron, John W.F.

TACONIAN FORELAND BASINS IN THE GULF OF ST. LAWRENCE REGION

WALDRON, John W.F., Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, AB T6G2E3, Canada, john.waldron@ualberta.ca, STOCKMAL, Glen S., Natural Resources Canada, Geol Survey of Canada (Calgary), 3303-33rd Street NW, Calgary, AB T2L 2A7, Canada, and DIETRICH, James R., Geol Survey of Canada, 3303 33 Street NW, Calgary, AB T2L 2A7, Canada

The Appalachian foreland basin offshore of western Newfoundland contains up to 5 km of Middle Ordovician to Lower Devonian sedimentary strata and covers over 50,000 km^2. Numerous seismic profiles allow correlation within the basin, but tie-points to onshore stratigraphy, and to well control, are scarce. Corresponding on-land successions are highly deformed in the Humber Zone of Newfoundland.

Initial Taconian deformation, interpreted to represent collision of an offshore Dashwoods microcontinent with an encroaching arc system, left little record on the margin of Laurentia. Subsequent closure of the intervening Humber Seaway led to margin subsidence and the diachronous arrival of easterly-sourced clastics above the former passive margin. Seismic images show that the margin was cut by numerous normal faults active at this time, interpreted to represent flexural extension of the lithosphere as it entered the Taconian subduction zone. Major normal faults, subsequently inverted as the Round Head and Parsons Pond thrusts) are exposed on Port au Port Peninsula and north of Bonne Bay. Their large throw (several km), unusual orientation, and the presence of thick rift-phase sediments in their hanging walls suggest an origin as reactivated basement structures associated with the St. Lawrence promontory.

Except in localized graben, the overlying clastic fill of the Middle Ordovician foreland basin (Goose Tickle Group) is thin, suggesting that Taconian Allochthons represented a small load on the Laurentian lithosphere, or were still located well to the east of their current position. Traced to the west beneath the Gulf, this basin fill is locally truncated unconformably at the base of the Late Ordovician Lourdes Limestone, a prominent reflector. An overlying clastic succession (Winterhouse and Misty Point formations) is much thicker than the Goose Tickle Group. Standard tectonic scenarios for the evolution of the Newfoundland Appalachians do not offer a straightforward explanation for this second phase of Taconian subsidence. It may have been driven by distributed thickening within the orogen (suggested by Ar-Ar dates on fabrics within the Humber Zone) or possibly by Late Ordovician thrusting on the transform segment of the Laurentian margin now hidden beneath the Gulf of St. Lawrence.

20-3 **8:45 AM** Ganis, G. Robert

STATUS OF THE COCALICO FORMATION, SOUTHEASTERN PENNSYLVANIA

GANIS, G. Robert, Consulting Geologist, P.O. Box 6128, Harrisburg, PA 17112, bobganis@aol.com and WISE, Donald, Department of Geosciences, University of Massachusetts, Ahmerst, MA 01003

The greenschist grade Cocalico Formation is a generally equivalent hinterland version of the allochthon-rich anchizone grade Martinsburg Formation in SE Pennsylvania. Stose (1946) included the Cocalico with the "Taconic Sequence in Pennsylvania", drawing comparisons to the allochthonous rocks in the Great Valley (GV) (foreland) of Pennsylvania where he proposed the "Hamburg klippe". The Cocalico is now recognized as complexly infolded with the Taconian nappes of the Lebanon Valley. It is composed of shale to coarser clastic rocks, including green and reddish-purple units that Stose called "tuffaceous" (unconfirmed).

The alternative to Stose's Hamburg klippe is allochthons thrust into the Martinsburg foreland basin. There, graptolites and conodonts have been used to separate autochtonous Martinsburg

SESSION NO. 18

18-7 10:00 AM Carter, Matthew J.*; Mosher, Sharon: **STRUCTURAL AND PETROGRAPHIC ANALYSIS OF THE CAMBRIAN UNITS AT BEAVERTAIL STATE PARK, RI**

18-8 10:20 AM Castonguay, Sébastien*; Skulski, Tom; van Staal, Cees R.; Currie, Maggie: **NEW CONSTRAINTS ON THE GEOLOGY OF BAIE VERTE PENINSULA, NEWFOUNDLAND: PART 2- STRUCTURE AND DEFORMATIONAL HISTORY OF THE PACQUET HARBOUR GROUP AND POINTE ROUSSE COMPLEX**

18-9 10:40 AM Skulski, Thomas*; Castonguay, Sébastien; McNicoll, Vicki; van Staal, Cees: **NEW CONSTRAINTS ON THE GEOLOGY OF BAIE VERTE PENINSULA, NEWFOUNDLAND: PART 1-TECTONOSTRATIGRAPHY OF OPHIOLITES AND THEIR VOLCANIC COVER**

18-10 11:00 AM Schoonmaker, Adam*: **STRUCTURAL EVIDENCE FOR SOUTHWEST-DIRECTED SUBDUCTION IN THE EARLY ORDOVICIAN ROCKS OF THE CAUCOMGOMOC LAKE INLIER, NORTHERN MAINE**

18-11 11:20 AM Massey, Matthew A.; Moecher, D.P.*: **LATE PALEOZOIC DEXTRAL TRANSPRESSION DRIVEN BY OBLIQUE CONVERGENCE, SOUTHERN BRONSON HILL TERRANE, MASSACHUSETTS**

18-12 11:40 AM Goteti, Rajesh*; Mitra, Gautam; Sussman, Aviva; Lewis, Claudia: **NEW INSIGHTS INTO THE EVOLUTION OF THE RIO GRANDE RIFT OF NORTH-CENTRAL NEW MEXICO FROM THREE DIMENSIONAL FINITE ELEMENT MODELING**

SESSION NO. 19

T2. NEtectonics: The Implications of Crustal Heterogeneity for Structure, Rheology, and Tectonics II

8:00 AM, Hyatt Regency Buffalo, Delaware Suites

Chris Gerbi, Michael Williams, and Scott E. Johnson, Presiding

8:00 AM **Poster session summary**

19-1 8:20 AM Jamieson, Rebecca A.*; Beaumont, Chrisopher: **SYN- AND POST-CONVERGENT DEFORMATION OF HETEROGENEOUS CRUST: NUMERICAL MODELS WITH APPLICATION TO THE WESTERN GRENVILLE OROGEN**

19-2 8:40 AM Hooks, Benjamin P.*; Koons, Peter O.; Johnson, Scott; Upton, Phaedra; Gerbi, Christopher; Pavlis, Terry: **RHEOLOGICAL CONTROLS ON THE FOCUSING OF DEFORMATION IN ACTIVE OROGENS**

19-3 9:00 AM Johnson, Scott E.*; Koons, Peter; West, David P. Jr.; Price, Nancy: **RHEOLOGICAL HETEROGENEITY AND THE STATE OF STRESS IN THE ROOTS OF A LARGE-DISPLACEMENT, STRIKE-SLIP, SEISMOGENIC FAULT: THE NORUMBEGA FAULT SYSTEM IN MAINE**

19-4 9:20 AM Cruden, Alexander*; Schrank, Christoph; Riller, Ulrich: **DEFORMATION LOCALIZATION DURING SHORTENING OF HETEROGENEOUS CRUST**

SESSION NO. 20

T6. Evolution of the Taconian Foreland Basin: Timing of Late Ordovician Sedimentological and Tectonic Events as Seen From Outcrop and Subsurface Sources I (Eastern Section of the Society for Sedimentary Geology (SEPM))

8:00 AM, Hyatt Regency Buffalo, Regency Ballroom

Gordon Baird, Charles E. Mitchell, and Carlton E. Brett, Presiding

8:00 AM **Introductory Remarks**

20-1 8:05 AM Lim, Chul; Kidd, William S.F.*: **FORELAND ZONE FAULTS AND VEINS RELATED TO ALONG-STRIKE PROPAGATION OF SLAB BREAKOFF AT THE END OF THE TACONIC OROGENY**

20-2 8:25 AM Waldron, John W.F.*; Stockmal, Glen S.; Dietrich, James R.: **TACONIAN FORELAND BASINS IN THE GULF OF ST. LAWRENCE REGION**

20-3 8:45 AM Ganis, G. Robert*; Wise, Donald: **STATUS OF THE COCALICO FORMATION, SOUTHEASTERN PENNSYLVANIA**

9:05 AM **Break**

20-4 9:25 AM Washington, Paul A.*; Chisisck, Steven A.: **SHALES, CARBONATES, AND STRUCTURE: EVIDENCE FOR TIMING OF TACONIAN OROGENESIS ALONG THE OUTER PORTIONS OF THE CAMBRO-ORDOVICIAN SHELF IN THE CHAMPLAIN VALLEY AND SOUTHEASTERN PENNSYLVANIA**

20-5 9:45 AM Washington, Paul A.; Chisick, Steven A.*: **CONTROLS ON LOCATION AND AREAL EXTENT OF THE QUEENSTON CLASTIC WEDGE IMPOSED BY THE PRE-TACONIAN SHELF ARCHITECTURE**

20-6 10:05 AM Agle, Paul A.*; Jacobi, Robert D.; Coulter, Stephen: **HORIZONTAL T/BR CORE FROM NYS: CONNECTION TO REGIONAL TECTONICS AND EXPLORATION IMPLICATIONS**

10:25 AM **Concluding Remarks**

SESSION NO. 21

T10. Formation Processes and Characteristics of Subglacial Bedforms beneath the Ice Sheets of Continental North America

8:00 AM, Hyatt Regency Buffalo, Grand Ballroom G

Dale Hess and John Menzies, Presiding

8:00 AM **Introductory Remarks**

21-1 8:10 AM LeFever, Alan M.*: **QUANTITATIVE MORPHOLOGICAL COMPARISON OF THE CHARLEVOIX-ANTRIM AND NORTHPORT DRUMLIN FIELDS, MICHIGAN USING DIGITAL ELEVATION MODELS**

21-2 8:30 AM Stahman, Douglas*; Evenson, Edward; Lawson, Daniel: **COMPOSITION AND SHAPE OF STREAMLINED BEDFORMS IN A PORTION OF THE WEEDSPORT DRUMLIN FIELD, NORTH CENTRAL NEW YORK**

21-3 8:50 AM Young, R.A.*: **SUBGLACIAL BED DYNAMICS DURING MIDDLE AND LATE WISCONSIN GLACIATION IN A MAJOR WESTERN NY VALLEY: PROCESSES RECORDED BY BASAL SEDIMENTARY STRUCTURES, GENESEE VALLEY, NY**

9:10 AM **Break**

21-4 9:30 AM Maclachlan, John C.*; Eyles, Carolyn H.: **EVALUATING DRUMLIN MORPHOMETRY WITHIN THE PETERBOROUGH DRUMLIN FIELD, ONTARIO, CANADA**

21-5 9:50 AM Hess, Dale P.*; Briner, Jason: **INVESTIGATING CONTROLS ON SUBGLACIAL BEDFORM MORPHOMETRY IN THE NEW YORK DRUMLIN FIELD – IMPLICATIONS FOR LAURENTIDE ICE SHEET PALEODYNAMICS**

21-6 10:10 AM Hyatt, James A.*; Rosiene, Joel; Gilbert, Robert: **MORPHOMETRIC ANALYSIS OF GLACIFLUVIAL EROSION FORMS IN BEDROCK, KANGERLUSSUAQ, GREENLAND**

10:30 AM **Discussion**

MORNING POSTER TECHNICAL SESSIONS

SESSION NO. 22

Hydrogeology (Posters)

8:00 AM, Hyatt Regency Buffalo, Grand Ballroom C

Authors will be present from 9 to 11 AM

Booth #

22-1 1 Becker, Laurence*; Kim, Jonathan; De Simone, David; Gale, Marjorie; Springston, George E.: **GROUNDWATER RESOURCES IN THE TOWN OF WILLISTON, NORTHWEST VERMONT**

22-2 2 *Tedone, Michelle**; Evans, Mark A.; Wizevich, Michael C.: **HYDROGEOLOGIC CHARACTERIZATION OF A MOUNTAINTOP SEEPAGE LAKE IN CENTRAL CONNECTICUT**

2008 Abstracts with Programs • Northeastern Section • Volume 40, Number 2

2008

Abstracts with Programs

43rd Annual Meeting

Northeastern Section

27–29 March 2008

Hyatt Regency Buffalo
Buffalo, New York

MARCH 2008 • ISSN 0016-7592