or 2) it is related to a younger event, such as uplift of the Transantarctic Mountains, or postulated strike-slip movement along the Byrd Glacier discontinuity.

245-16 **5:15 PM** Hanson, R.

CORRELATION OF 1.1 GA LARGE IGNEOUS PROVINCES ON THE LAURENTIA AND KALAHARI CRATONS: IMPLICATIONS FOR RODINIA RECONSTRUCTIONS

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Synchronous emplacement of large igneous provinces on the Laurentia and Kalahari cratons at ca. 1.1 Ga provides an important constraint on relative positions of the two cratons within the Rodinia supercontinent. The Laurentian province is best represented by the Midcontinent rift (MCR), where published data (including high-precision U-Pb geochronology) indicate that 75% of the total volume of basaltic magma was emplaced at 1108-1105 Ma, during an interval characterized by generally uniform magnetic polarity with sporadic, brief reversals. Traditionally, a reversed polarity has been assigned to this interval, to distinguish it from a succeeding long interval of "normal" polarity.

In southern Africa, the Umkondo igneous province on the Kalahari craton includes widespread mafic intrusions in eastern Botswana, Zimbabwe, and South Africa. Eleven separate intrusions have now yielded conventional U-Pb zircon or baddeleyite ages of ca. 1111-1105 Ma. Bimodal magmatic rocks within the province in western Botswana and Namibia have identical ages. Based on published paleomagnetic data and our new work, 60 sites from Umkondo intrusions and lavas in southern Africa have yielded statistically indistinguishable directions of magnetization. Forty eight of these sites have the same polarity. We infer that the majority of the Umkondo province was emplaced in a narrow time frame during the "reversed" interval documented from the MCR. The close similarity in timing of these major magmatic events makes it highly unlikely that they developed on unrelated cratons. Correlation of the Umkondo igneous event with 1108-1105 Ma magmatism in the MCR removes the ambiguity in polarity assignment inherent in Precambrian paleomagnetic studies and supports a Rodinia reconstruction in which Kalahari is located south of Laurentia, aligning the two igneous provinces behind a single convergent margin defined by the Grenville and Namaqua-Natal orogenic belts. However, this configuration does not align the Umkondo and MCR poles, and further work is required to produce a Rodinia model that can resolve this discrepancy.

SESSION NO. 246, 1:30 PM

Wednesday, October 30, 2002

T121. Tackling Transpression and Transtension in Orogenesis: Tools of Structural Geology from Microfabric to Tectonic Reconstruction (Posters) (*GSA Structural Geology and Tectonics Division*)

Colorado Convention Center, Exhibit Hall

246-1 **BTH 146** Roselli, Carlos G.

DEFORMATION OF SEDIMENTARY ROCKS DURING LATE PALEOZOIC TRANSPRESSION ALONG THE AVALON-MEGUMA TERRANE BOUNDARY, NOVA SCOTIA

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Devonian to Permian sedimentary successions in the Appalachians of Atlantic Canada record intense deformation in narrow zones related to intracontinental transform faults active during the assembly of Pangea.

On the south shore of the Minas Basin, Nova Scotia, Late Paleozoic deformation affects the Mississippian Horton and Windsor Groups, dominated by clastic lacustrine deposits and evaporites respectively. These rocks appear intensely deformed on the south shore of the Minas Basin (Bay of Fundy), immediately south of the Meguma-Avalon terrane boundary, within the Canadian Appalachians. Structures exposed in cliffs and on wave-cut platforms include reverse faults and tight folds with incipient axial-planar cleavage. A complex interference pattern was identified employing different map scales, recording a history of progressive deformation. Locally, overprinting has led to the development of downward-facing folds. Faults, marked by sheets of quartz with slickenfibres, were developed both before and after folding. In some instances, faults and folds are associated in outcrop-scale flower structures exposed in both cliff and wave-cut-platform view.

Low angle thrust faults and oblique strike-slip faults played a role in emplacing Horton Bluff Formation strata over younger strata of the Upper Horton Group and Lower Windsor Group. In seismic profiles, contorted reflections representing Windsor evaporites occur beneath areas mapped as older Horton Group, suggesting the presence of map-scale reverse faults or thrusts. Thrusting and strike-slip motion were followed by diapirism of Windsor evaporites, and probably also by solution-collapse, generating breccia zones in contact with Horton successions,.

This deformation was associated with transpressional motion along the boundary between the Meguma and Avalon terranes of the Appalachians. Stratigraphic relationships and isotopic ages obtained from dykes constrain the timing of deformation close to the Mississippian-Pennsylvanian boundary. The area provides an excellent opportunity to study and quantify the effects of transpression in deformed sedimentary rocks at very low metamorphic grade, and to document the behaviour of salt-detachment surfaces in transpressional environments.

246-2 **BTH 147** Kidd, William S.F.

DIFFICULTIES IN CONSTRAINING CRUSTAL DISPLACEMENT PATHS AT NANGA PARBAT, WESTERN HIMALAYAN SYNTAXIS

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Nanga Parbat - Haramosh Massif (NPHM) marks the western tip of the Himalaya arc; the syntaxis. In this region, crustal displacements are complicated by the interplay of the "normal" convergence of the Indian plate (~NNW) with the accumulation of the expanding arc as collision progresses (resulting in a strong partitioning of strain with the arc-parallel direction). At NPHM this results in very young plutonism, metamorphism and exhumation. Here, two steep, ~NNE trending, ~conjugate [pro- & retro- geometries], 30-50 km long, crustal-scale, thrust-displacement shear zones have allowed the ~25 km wide core of the massif to be uplifted in a pop-up mechanism but the 3D nature of the flow history is complex, in particular closer to the core. The conjugate shear zones are accompanied by large age gradients in cooling & plutonism that young inwards (i.e. towards the core), and focussed hydrothermal activity. The leading, or pro, thrust, located on the NW side of NPHM is better defined than the retro thrust (the SE side). Foliation orientation, lineation plunge, and sense-of-shear indicators are consistent throughout the pro thrust, and both shear zone margins are are recognisable by abrupt changes in deformation fabric. The retro thrust, however, broadens from a few to >10 km to the south (away from the core of the massif), accompanied by a gradual 180o change in fabric orientation (which the sense-of-shear indicators track), and only the external margin is clear. Yes, these two zones have allowed significant vertical displacement of the upper crust, but good spatial and temporal displacement constraints are tricky; the host rock is a pre-existing high strain fabric that is steeply dipping, ~N-S trending with N-plunging mineral, fold hinge & intersection lineations. It comprises a 10's km thick shear zone that formed during the earlier main Himalayan N-S convergence. This records a broader range of deformation conditions than that subsequently preserved in the conjugate shear zones, creating difficulties in separating deformation events. Additionally, synkinematic plutonism, especially within the retro shear zone, was localised but recurring throughout the shear zone evolution, providing local foci into which strain was preferentially partitioned thereby further obscuring the finite deformation history

246-3 **BTH 148** DeJong, Kees A.

STRUCTURAL STYLE OF THE KOHAT PLATEAU, PAKISTAN: TRANSPRESSION TECTONICS, MULTIPLE DETACHMENT FAULTING, AND GRAVITY SPREADING

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Fold-and-thrust belts form the geological backbone of Pakistan, and strike-slip faults are subordinate to the folds and thrust faults, with the possible exception of the Kohat Plateau where the main E-W structures have been recently explained as the result of transpression tectonics (Sercombe, Pivnik, et al, Bull.AAPG, 1998). Fault structures with a vertical offset of a few km were described as 'flower' structures. Seismology and faults with subhorizontal striae indeed indicate the presence of E-W strike-slip faults.

An overview of the structural style of the Kohat Plateau was derived from satellite imagery analysis, and near the village of Gandiali a 120 km2 area was mapped 1:25,000. Detachment occurred below the Jurassic in the Tolanj Anticlinorium, below the Ghazij shale (Paleocene) and in the Kuldana shale (Eocene). N-S shortening in the study area, mainly by tight upright folds, is 10-15 km min. whereas offset resulting from E-W strike-slip faults appears absent. The overturning of E-W oriented anticlines towards both N and S could be considered as the result of transpression tectonics (flower structure) but 'collapse' of a fold during its growth is an alternative explanation. The termination of minor folds at the Algad River in the Tolanj anticlinorium is also suggestive of 'morphotectonics'.

The major structural features of the Kohat Plateau include a regional detachment fault below the Jurassic and local detachments in Eocene formations resulting in thrust sheets and folds. These detachment features indicate crustal compression, although the smallest klippen may have been emplaced gravitationally. The doubly-overturned folds and other small structural features probably resulted from gravity tectonics. Transpression tectonics is evident in the area of the N-S oriented Kalabagh fault.

246-4 **BTH 149** Holdsworth, R.E

THE GEOMETRY AND KINEMATICS OF SHEATH FOLDS

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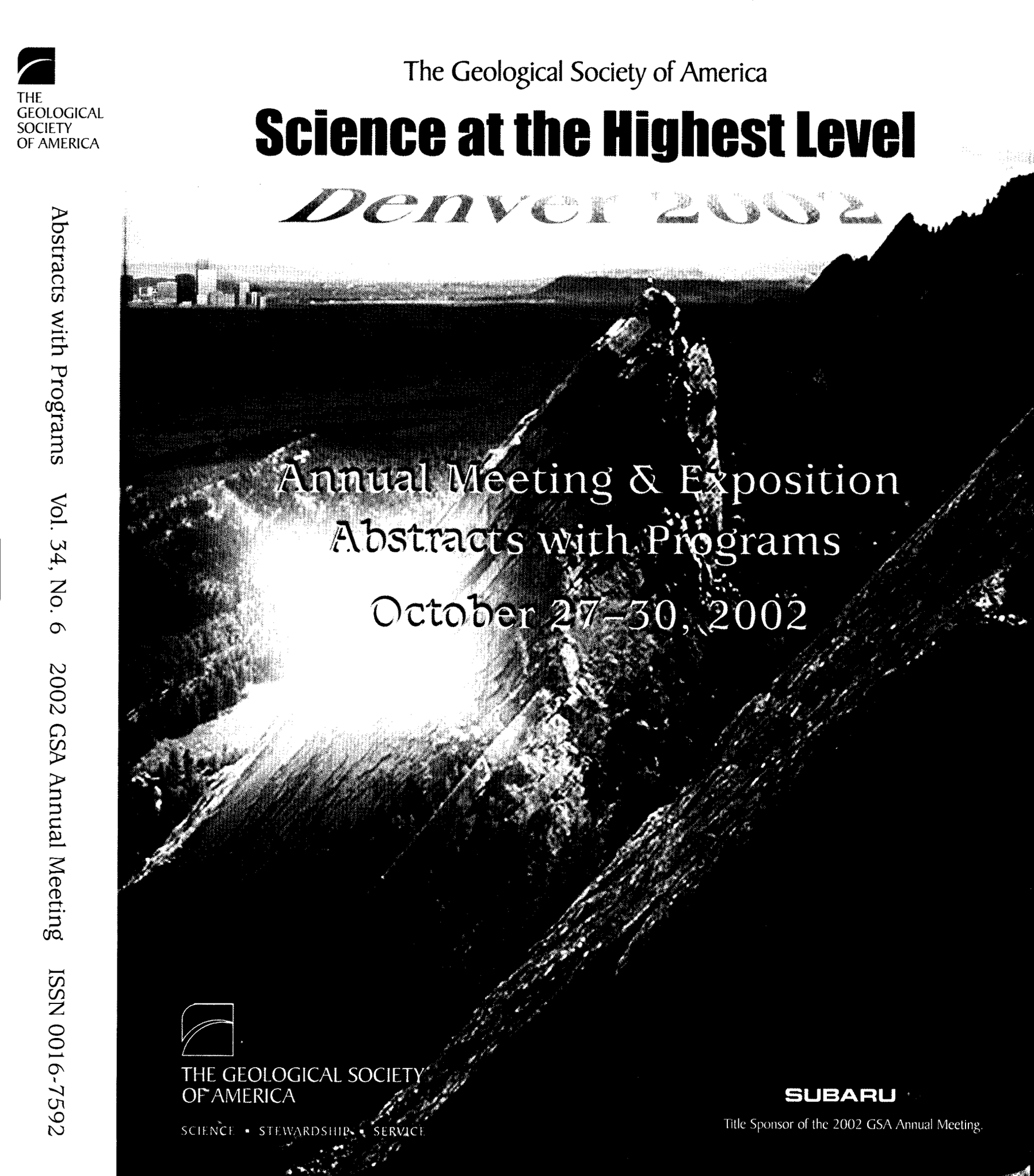
Sheath folds are clasically depicted as displaying symmetrical geometries about two orthogonal mirror planes centred along the (X-Y) axial surface and the (X-Z) medial (culmination/depression) suface whch bisects the fold nose. Detailed topological analyses of minor folds and fabrics associated with major curvilinear dome and basin sheath folds in the Caledonides of N Scotand reveals however, that sheath folds display distinct and predictable asymmetries across both axial and medial surfaces. Seven robust geometric parameters are identified which provide an effective means of monitoring planar and linear fabric rotations with increasing deformation within any system of coherent shear. They consistently display systematic variation from regions of lower to higher strain on passing from upper to lower fold limbs across major axial surfaces, and on crossing medial surfaces from short to long hinge-line segments related to fold hinge-line vergence. Axial and medial surfaces effectively divide major sheath folds in to quadrants with different amounts, senses and combinations of planar and linear fabric rotation within each domain. Only limited rotations occur on the upper limbs within short hinge-line segments, whilst the greatest deformation ccurs on the lower limbs on long hinge-line segments. Major medial surface separate hinge rotations of opposing sense and hence effectively delineate the trend of tectonic transport even in areas where lineations are poorly preserved. The sense of rotation of minor fold axial planar strike towards the shear plane (marked by the foliation) is governed by minor fold (Z/S) geometry and hence location relative to the major axial surface which separate minor axial plane rotations of an opposite sense. Minor fold hinges and axial planes may thus rotate in the same (synthetic) sense or in opposing (antithetic) directions depending on position relative to major axial and medial surfaces. Bedding/cleavage intersections are developed at greater angles to the transport direction than fold hinges which they transect in a consistent and predictable sense thereby confirming the direction of fold rotation even in areas which lack information on fold facing.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