GSTT Technical Note

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Field Trip - Northern Range

Systematic east to west variations in deformation temperatures, structural fabrics and structural architecture models, Northern Range, Trinidad

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Introduction

On April 29, 2000 Dr. John Weber led GSTT members on a Field trip to the Northern Range, Trinidad. The main objective of this one-day trip was to study systematic changes in deformation temperatures and structural fabrics from east to west across the Northern Range.

Frey et al. (1988) presented an excellent study of metamorphic mineral paragenesis in the range, which demonstrated that the rocks experienced peak metamorphic temperatures of 300-400°C. The study however did not resolve internal variations in grade across the range. This trip will examine features related to the east-west increase in D_1 deformation temperatures (~metamorphic grade) and variation of structural fabrics (subhorizontal to subvertical) documented in Weber et al. (in press). D_1 was the earliest and most pervasive deformation event in the range; it produced the majority of the fabrics that will be observed.

The two main field stops (Lady Chancellor Road and Tompire Bay, Figure 1) are representative end-members that will encourage participants to contrast the rocks, structures, and fabrics, in the structurally lower western domain with those in the overlying eastern domain, Figure2. Supplemental microstructural color photo-micrographs (from Weber et al. *in press*) were shown on the outcrop, and maps presenting results from Weber et al. (in press) geothermometry study were provided in this field guide.

Western (Mid-Crustal) Tectonic Domain

STOP 1: Upper Lady Chancellor Road

Rocks in the western Northern Range are ductilely deformed, mid-crustal, metasedimentary rocks, including quartz schist, carbonate schist, and mica schist. D_1 deformation temperatures of 300-400°C are interpreted (Weber et al. in press) from the reset zircon fission tracks and completely recrystallized calcite (Type 5) and quartz (Regime 3) microstructures found in this rock unit. These rocks have subhorizontal D_1 fabrics with E-W stretching lineations.

Fig 1: Outcrop of quartz-mica and carbonate schist along the Lady Chancellor Road, western Northern Range. Note late (F2) fold (kink) of S1 metamorphic oliation (layering), which in general dips gently (20 - 30 degrees or less) across much of the western and central Northern Range

Most original sedimentary features in the rocks, including their original stratigraphy, have been destroyed by the intense ductile shape changes that these rocks have experienced (~10:1 flattening and stretching).

This intense shape change (i.e., strain) is manifested in the ubiquitous tight-isoclinal D_1 folds and an intense, pervasive S_1 foliation that makes up the dominant layering in these rocks. Transposition is the name given to the process of the replacement of an old rock layering, in this case bedding (S_0), with a new tectonic layering (S_1). The current large-scale structural model for the Northern Range is that of a northward overturned macroscopic anticline (Potter, 1973; Algar 1993). This model is perhaps inappropriate as it is based on correlating a now nonexistent protolithic stratigraphy across the transposed rocks in the western Northern Range. Throughout the trip emphasis was placed on discussing the on-going attempts at building a new structural architecture model(s) for the Northern range (e.g., Weber et al. in review). Put simply, the Northern Range can be an intact crustal block that is tilted and plunging toward the east. Relatively high-grade, mid-crustal rocks would be exposed in the western Northern Range. Traversing eastward across the range, the exposures should systematically grade into the upper crustal rocks of the Toco district.

Eastern And Northeastern (Upper Crustal) Tectonic Domains

The rocks in the eastern Northern Range are a mixed bag of upper crustal rocks, which can be divided into an eastern and northeastern domain. The northeastern domain includes the San Souci basalt, Toco mélange (Algar, 1993), shallowly dipping and largely overturned Galera outcrops, and regions of subhorizontal–moderately dipping S_1 (e.g., between Toco and Matelot). Only reconnaissance-level work has been done in these rocks and these northeastern domain rocks will not be examined on this trip.

Eastern (Upper Crustal) Tectonic Domain

STOP 2: Tompire Bay, Guyamara Point.

Many of the metasedimentary rocks (slates, metasandstones, and metacarbonates) in the eastern Northern Range tectonic have preserved upright (subvertical) D_1 fabrics (e.g., see the map of Barr 1965) with geometries and kinematics akin to those at the surface in the Central Range.

Fig 2: Folded bedding (S0) at Tompire Bay, south of the Toco region, Northern Range. S1 slaty cleaveage is well developed in metamudstone beds in fold nose. In general both bedding (S0) and cleavage (S1) are upright(subvertical) across much of the eastern Northern Range

These include: folds with subvertical, NE-SW striking axial planes, and subhorizontal NE-SW trending hinges; dextral thrusts (Weber and Ferrill in press). Although they have similar structures, the eastern Northern Range domain rocks however have been buried to greater depths than those presently at the surface in the Central Range.

The eastern Northern Range domain rocks have non-reset zircon fission tracks, type III calcite twins, and regime 1-2 quartz microstructures, indicating upper-crustal D_1 deformation temperatures of 200-300°C (Weber et al. in press). Weber et al. (in review) propose that the upright fabrics in this domain are part of a patch of the upper crustal fold-thrust-strike-slip belt that has not been eroded off the top of the low, eastern end of the Northern Range (Figs 3 & 4).

Fig 3

Range-Front Sub-Domain

STOP 3: Lower Lady Chancellor Road, Champs Fleurs

This additional stop examines the structures along the southern boundary of the Northern Range. Range-front upright folding is geometrically identical to that in the eastern (upper) domain, but the range-front folds are folds of the S_1 foliation, not bedding (S_0). These rocks and structures are interpreted to be transitional, having formed at structural levels spanning those of both the upper and lower domains discussed above. The range-front faults and shear bands observed here were interpreted by Weber et al (in press) to conclude that the most recent motions have been down-to-the-south normal faulting along this boundary. Weber et al. (in press) interpreted that such range-front normal fault displacement decreased from east-to-west, causing the eastward tilting of the Northern Range, and the east-to-west D_1 deformation temperature differential discussed above.

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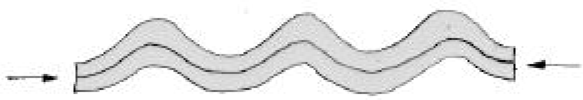
STRUCTURAL CODING SYSTEM
(Davis and Reynolds, 1996)

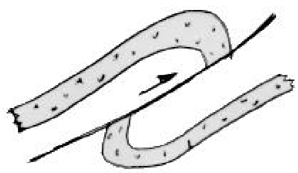
D_i = Deformation event; i = 1, 2, 3 . . . .
F_i = A "generation" of folds produced during a deformation event; i = 1, 2, 3 . . . .
eg. F_1 folds form during D_1, etc.

Types of Folds:

1. Buckle folds or Free folds (wave trains)



2. Fault-related (fault-bend, fault-propogation) or forced folds
   (no wave trains only single fold)



S_i = A planar foliation (new tectonic/ metamorphic layering reflecting shape change - flattening) produced during a deformation event; i = 1, 2, 3 . . . .
** NOTE: S_o is reserved for sedimementary bedding or other primary layering **

Types of Foliation:

1. Schistosity
2. Slaty cleavage
3. Other

- Generally a single deformation evemt produces folds with an axial planar foliation
- Transposition - replacement of old layering by new tectonic layering via deformation.

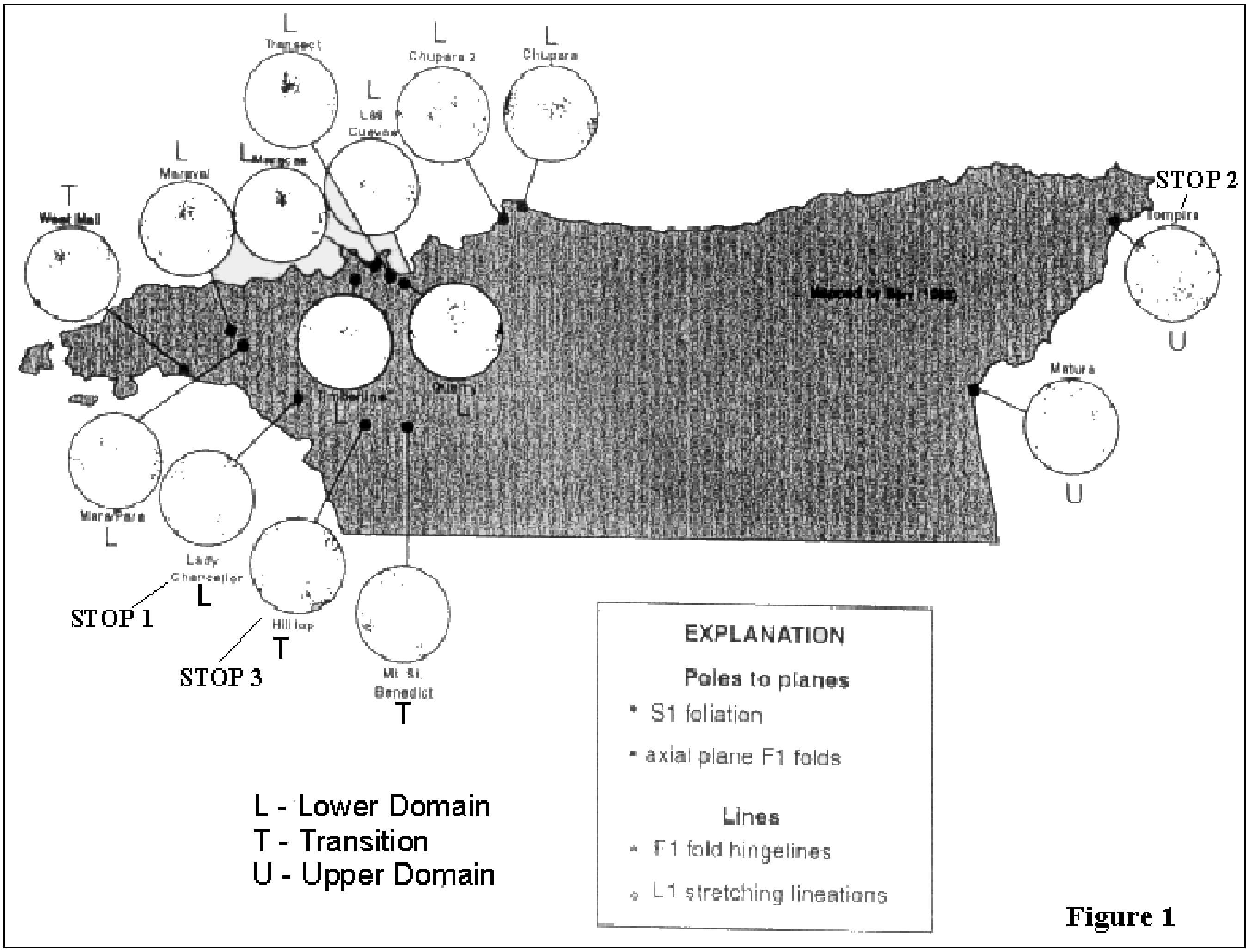


Figure 1

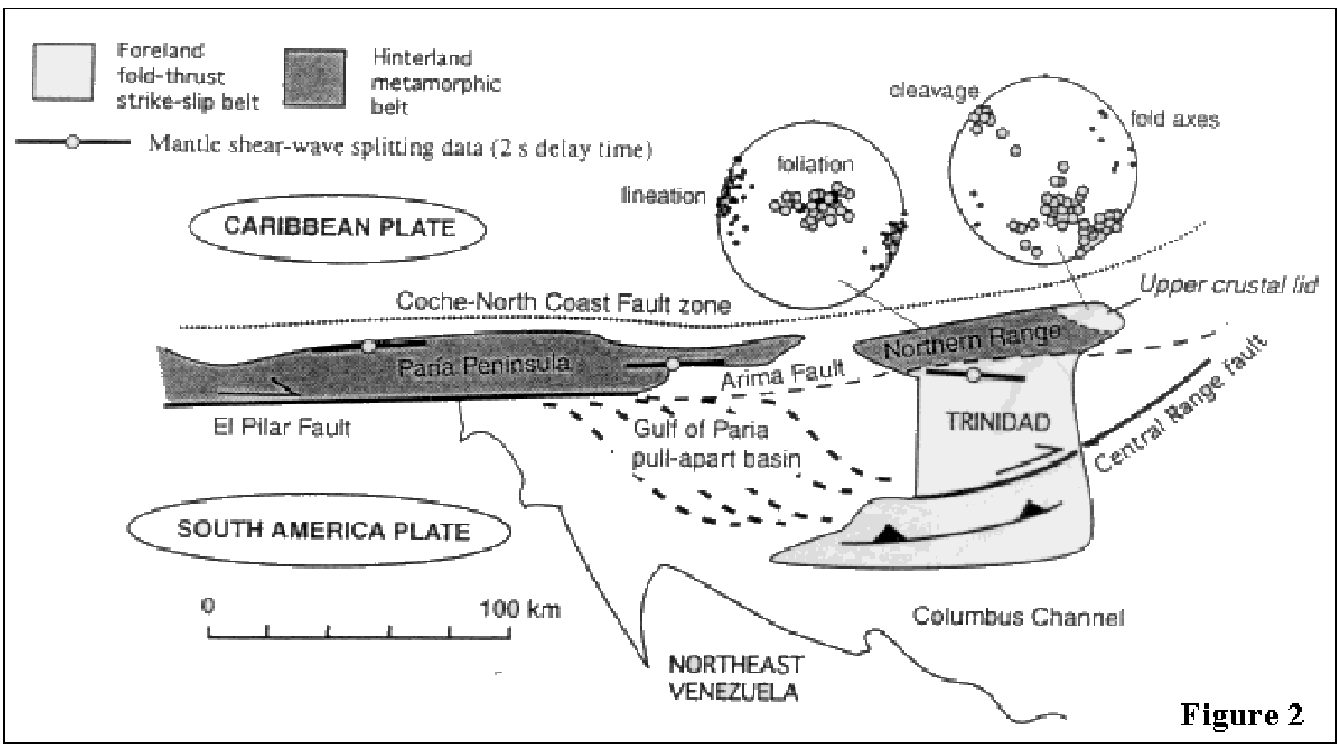


Figure 2

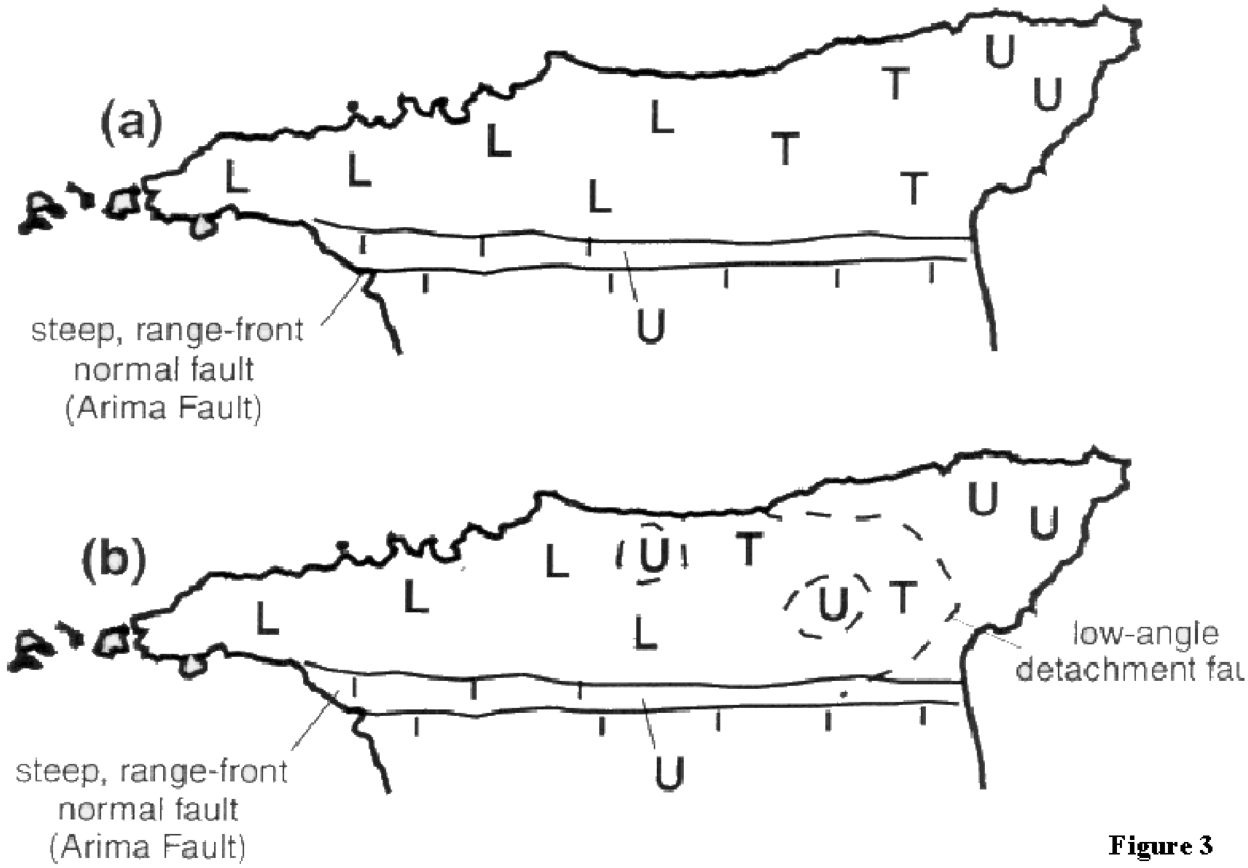


Figure 3

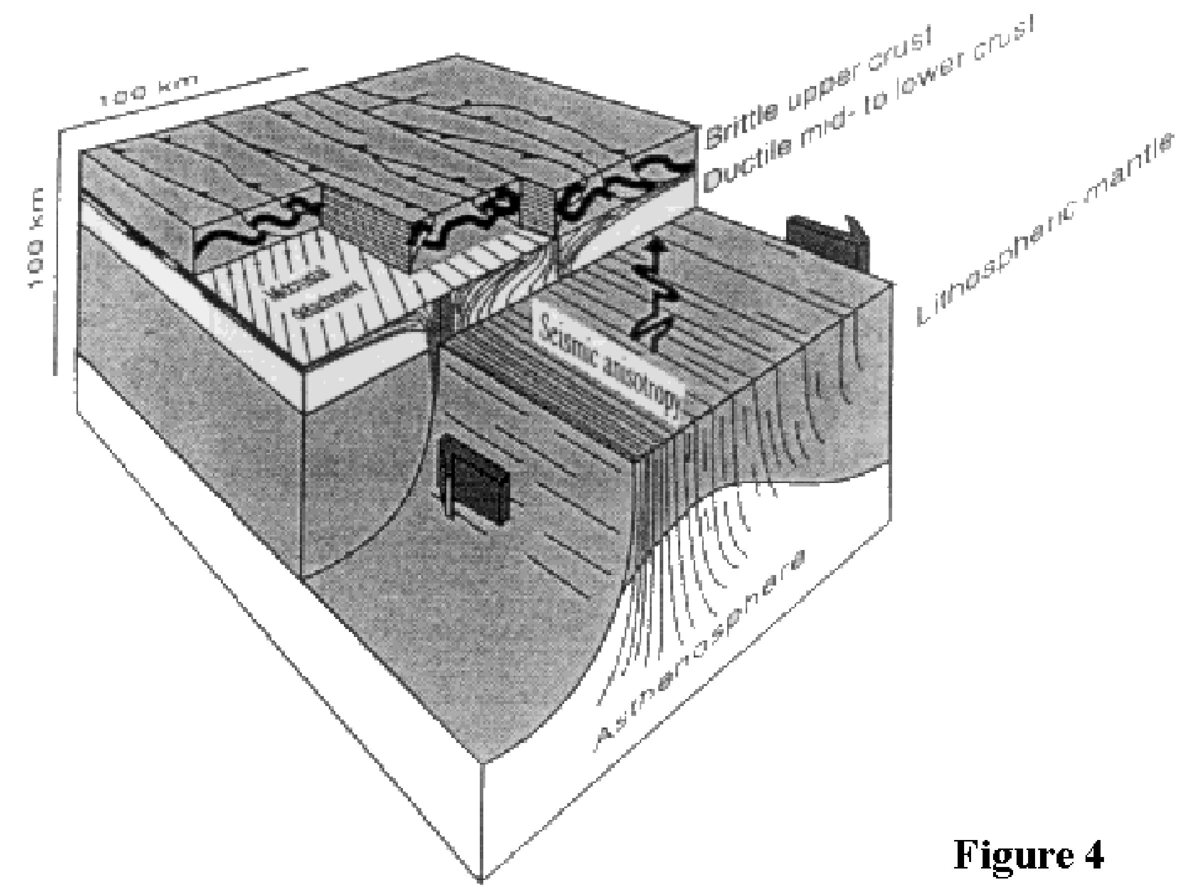


Figure 4