GEOLOGY OF EL PROGRESO QUADRANGLE
NORTH OF THE MOTAGUA RIVER

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ABSTRACT

The oldest rocks in El Progreso quadrangle are a complex Paleozoic metamorphic assemblage known as the Chuacús Group. Most of these rocks are meta-sediments which range in grade from the greenschist to the amphibolite facies. The uppermost formation of this group is the Jones Formation which consists primarily of mica schist and gneiss, and includes the San Lorenzo marble member in the upper portion of the assemblage. In the lower portion of the Jones Formation is a unique hornblende gneiss lithology restricted to a small region in the eastern part of El Progreso quadrangle. This unit is either a small stock or a separate formation within the Chuacús Group that has been transposed to a higher stratigraphic level. The uppermost unit in the Chuacús Group is a muscovite schist Formation.

The next major tectonic event in this region probably began in the late Mesozoic and is associated with faulting along the Motogua fault zone which also resulted in the emplacement of serpentinite intruded through and thrust over the Chuacús Group. Two distinct serpentinite belts cut across the map area. The first belt parallels the Motagua Valley and consists of two types of serpentinite. The first type is composed of unoriented antigorite and has a platy to sucrosic texture. The other variety has a bastitic texture. The second serpentinite belt bifurcates from the first belt in the western part of the quadrangle and has a more northeasterly trend. It is composed only of the sucrosic serpentinite.

Chuacús lithologies near the serpentinite belts exhibit secondary M_2 metamorphic overprinting. Also associated with the serpentinites and M_2 metamorphism is a complex tremolitic amphibolite formation. Overlying all of these rocks in low lying areas are deposits of volcanic ash and ignimbrites.

INTRODUCTION

The location of El Progreso 10 X 15 minute quadrangle is on the southwestern side of the Sierra de las Minas Range (Fig. 1). The Motagua fault zone extends through the southern half of the quadrangle parallel to the Motagua River valley. The purpose of this report is to outline the geological relationships of the region north of the fault zone.

The first reconnaissance mapping in this area was done by McBirney (1963) in the northwestern part of the quadrangle. Later, Bosc (1971, unpublished) presented a map of the northeastern portion. The entire El Progreso quadrangle north of the Motagua River was remapped by the author in the summer of 1971. The map resulting from this investigation is presented in Fig. 2.

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In order better to understand the Late Tertiary and Holocene tectonic activity along the Motagua fault zone it is necessary to be able to recognize the older geology of the region. In this manner it is possible to perceive tectonic overprinting on ancient structures so that only the more recent tectonic events can be studied in a less ambiguous manner.

The geology of this region can be characterized as having been modified by two distinct and different types of tectonic activity. The oldest event, probably of middle Paleozoic age, involved recumbent polyphase folding accompanied by medium grade dynamothermal regional metamorphism. The later event began in the late Mesozoic with faulting along the Motagua fault zone. Related to this faulting was the emplacement of serpentinite thrust sheets, which caused contact metamorphism and metasomatism of the rocks below the sheets. Some minor activity also occurred at this time along the fault zone.

PALEOZOIC GEOLOGY

The oldest rocks in El Progreso quadrangle are the Chuacús Group which is a complex assemblage of metamorphic lithologies. These rocks range from the greenschist to the amphibolite facies of regional metamorphism in the study area. The age of these rocks is controversial. However, they are known to underlie the Santa Rosa and Chochal Formations, the latter of which is Permian in age (McBirney, 1963; Vanden Boom 1972). Radiometric dates on these rocks range from Precambrian to Tertiary (McBirney and Bass, 1959: Williams and McBirney, 1969; Bosc, 1971). The Tertiary ages are probably due to tectonic overprinting, and the Precambrian date is suspect because it was obtained from partially recrystallized zircons. Thus, the most acceptable dates for these rocks are middle Paleozoic (Gomberg and others, 1968; Pushkar, 1968).

Attempts have been made by Bosc (1971), Newcomb (1975), and Roper (1973, 1976) to subdivide the Chuacús Group in the Sierra de las Minas Range into formations. In order to maintain continuity in nomenclature, the formation names proposed by Newcomb (1975) will be used in this paper where they can be applied, although there are some disagreements of interpretation with regards to the stratigraphic position and significance of some of these formations.

The lowest formation of the Chuacús Group is the San Agustin Formation which consists of various kinds of cataclastic gneiss of meta-igneous origin and a migmatite zone. This formation has not been recognized in El Progreso quadrangle, and is only found to the east of the study area where the Sierras are uplifted more and deeper and older rocks are exposed.

Conformably overlying the San Agustin Formation is a complex sequence of mica schist and gneiss of meta-sedimentary origin known as the Jones Formation. Some distinctive rock types are recognized in the Jones Formation, but due to the complex polydeformation and metamorphism the exact stratigraphic relationship of these units within or with respect to the rest of the Jones Formation is not well established. They are included with the Jones Formation (Fig. 2) as separate units because Jones Formation lithologies occur above or below them.

Structurally, the lowest of these units is a medium to coarse grained hornblende gneiss with felsite dikes. This rocktype has only been found in the northeastern part of El Progreso quadrangle. The significance of this unit is uncertain. It could be a transposed portion of the basal Jones formation by either faulting or complex sheared-out folding, but it is also possible that it could be an intrusive pluton. A name has not been assigned to this unit because of these ambiguities.

One of the best marker horizons in the Chuacús Group throughout the south side of the Sierra de las Minas Range is a very pure calcite marble known as the San Lorenzo

Formation. Newcomb (1975) suggested that these rocks be recognized as a separate formation, that overlies the Jones Formation, from exposures farther to the east and northeast in the San Agustín Acasaquastlán and Río Hondo quadrangles. However, in El Progreso quadrangle where the upper sequences of the Chuacús Group are better preserved and exposed it can be demonstrated that Jones Formation lithologies lie above and below the San Lorenzo marble. For this reason it is regarded only as a marker horizon, rather than a separate formation, in the upper portion of the Jones Formation of this report.

Overlying the Jones Formation in the northwestern corner of El Progreso quadrangle is another formation composed predominantly of muscovite schist and some micaceous quartzite. This is the highest recognized structural and stratigraphic formation within the Chuacús Group.

The companion article with this paper demonstrates that the Chuacús Group experienced polyphase folding during the Paleozoic deformation which resulted in the formation of a recumbent nappe that approximately parallels the Sierra de las Minas Range. Regional metamorphism accompanied this tectonism and ranges from the greenschist to the amphibolite facies in the study area. In general the lower grade metamorphic facies occur in the western part of the map area, and the highest grade metamorphic rocks are in the northeastern corner of the quadrangle. This distribution is in agreement with the interpretation that the northwestern part of El Progreso quadrangle is represented by the upper low grade layers of the refolded nappe; whereas farther to the northeast uplift is greater and thus exposes the higher grade metamorphic rocks deeper in the interior of the nappe.

POST PALEOZOIC GEOLOGY

Serpentinite

The next major tectonic event recorded in this region was associated with faulting and emplacement of serpentinite thrust sheets which originated from the Motagua fault zone. The inception of this tectonism is open to question. These events are definitely post-recumbent folding and regional metamorphism. Donnelly and others (1974) suggested from stratigraphic studies that at least the serpentinite emplacement occurred sometime after deposition of the Todos Santos (Aptian-Albian) Formation.

Fig. 2 delineates two irregular belts of serpentinite. The first belt forms an irregular zone that approximately parallels the northern border of the Motagua fault zone. The second belt begins in the western portion of the quadrangle and bifurcates off the first belt and trends in a more northeasterly direction.

The northeastern belt divides the Chuacús rocks in the northern half of the quadrangle into a northwestern and northeastern section. The belt continues into the San Jeronimo quadrangle to the north and appears to parallel the southern side of an arcuate ridge that extends into El Cimiento quadrangle to the east. The serpentinite in this belt ranges from a sucrose to a fine grained platy texture due primarily to unoriented antigorite crystals. Foliation is not well developed in these rocks, although large road cuts reveal an undulatory subhorizontal foliation in places thereby suggesting that much of this mass was emplaced as a large thrust sheet. The thrusted relationship between the serpentinites and the underlying Chuacús rocks is impressively exposed in the southwestern part of the map area (Fig. 2). Equally spectacular are smaller subhorizontal allocthonous sheets of sucrosic serpentite perched on the tops of small hills in the eastern part of the study area just north of the Motagua valley (Fig. 2). The irregular outcrop pattern on the northern side of the belt, as well as subhorizontal zones of sheared serpentinite within the belt provide additional credibility to this interpretation. However, the relatively

straight trend of this zone in the map area along with its projected arcuate trend in the San Jeronimo and El Cimiento sheets suggest that segments of the lower portion of the serpentinite belt could be intrusive. Thus, field relationships suggest that initially segments of this belt formed by intrusion along an arcuate fissure, which later was capped by an overriding serpentinite thrust sheet or sheets which probably originated farther to the south in the Motagua valley.

The belt that parallels the northern boundary of the Motagua valley consists of irregular masses of two types of serpentinite separated by massive bodies of amphibolites and slaty phyllites. Serpentinite with a platy to sucrosic texture also occurs in large quantities in the western and northern portions of this belt. Unique to this zone is a second textural variety of serpentinite characterized by bastite pseudomorphs after pyroxene. Mineralogically, these rocks consist primarily of antigorite and bastite pseudomorphs. Chemically, they are identical to the platy or sucrosic textured serpentinite.

Foliation is not well developed in these rocks, but where it has been observed it is usually at a much steeper angle than the foliation found farther to the north, associated with thrust sheets. Furthermore, in some localities it is clearly demonstrated that the serpentinite has an intrusive relationship to the adjacent rocks. This relationship becomes more pronounced as the Motagua valley is approached; thus suggesting that the root zone for the thrust sheets is from this region.

Many steep valleys and hillsides have accumulated large amounts of colluvial serpentinite that has since been lithified into conglomerate. Such sedimentary serpentinites have boulders greater than two feet in diameter. Most of the serpentinite forming the clasts in these conglomerates is of the bastitic variety. No attempt was made to distinguish sedimentary serpentinites as a separate formation due to lack of time in mapping this region.

Amphibolite

Surrounded by and intercalated with the serpentinite bodies is a complex suite of rocks composed predominantly of tremolitic amphibolite. The irregular though close proximity of these rocks with serpentinites seems to be one of the unique features of the unit. In addition to tremolite, other rock types such as mica schist, phyllite, marble and mylonite are found locally within this unit. The amphibolites are intruded by many small serpentinite dikes, most of which are not resolvable at the scale of the map, and makes tracing of individual rock units difficult.

Chemical analyses of these rocks indicate that they range from ultrabasic to andesitic in composition, with an average approximately that of tholeiitic basalt suggesting that many of these rocks are metamorphosed dikes, sills and flows. However, some types, especially the ultra basic amphibolites, also have anomalously high or low concentrations of CaO, MgO, and Al_2O_3 suggesting either an introduction or removal of materials during metamorphism, or post-tectonic replacement of mineral matter or both. Petrographic studies of relict textures of amphibolites with SiO_2 contents in the andesite range suggest that these rocks were derived from partial metasomatism of pre-existing Chuacús mica schist and gneiss.

The amphibolites generally exhibit well developed foliations which indicate at least two phases of folding. Roper et. al. (in press) have shown that this fabric is structurally distinct from the polydeformational fabric found in Chuacús rocks. The orientation of fold axes and axial planes suggest that these structures are genetically related to fissures or thrust planes from which the serpentinite masses were emplaced. Thus, the emplacement of serpentinite seems to be responsible for both the formation and deformation of the amphibolites. Such a relationship would account for the diversity of lithologies in these rocks, the metamorphism and metasomatism, the type and orientation

of deformation fabric, and the unusual outcrop pattern which is always associated with serpentinites in one way or another.

Volcanic Ash and Alluvium

Unconformably overlying all other rocks, especially on the floors of large valleys, or even on plateaus at higher elevations, are thick deposits of volcanic ash, ignimbrite and pumice. The thickest deposits occur along the Motagua River valley. The lower portion of the Morazán valley is also covered with a thick ash. Mixed with the pumice and ash are fragments of vesicular basalt and obsidian. Locally, channel scars are present. No attempt was made to subdivide these surficial deposits.

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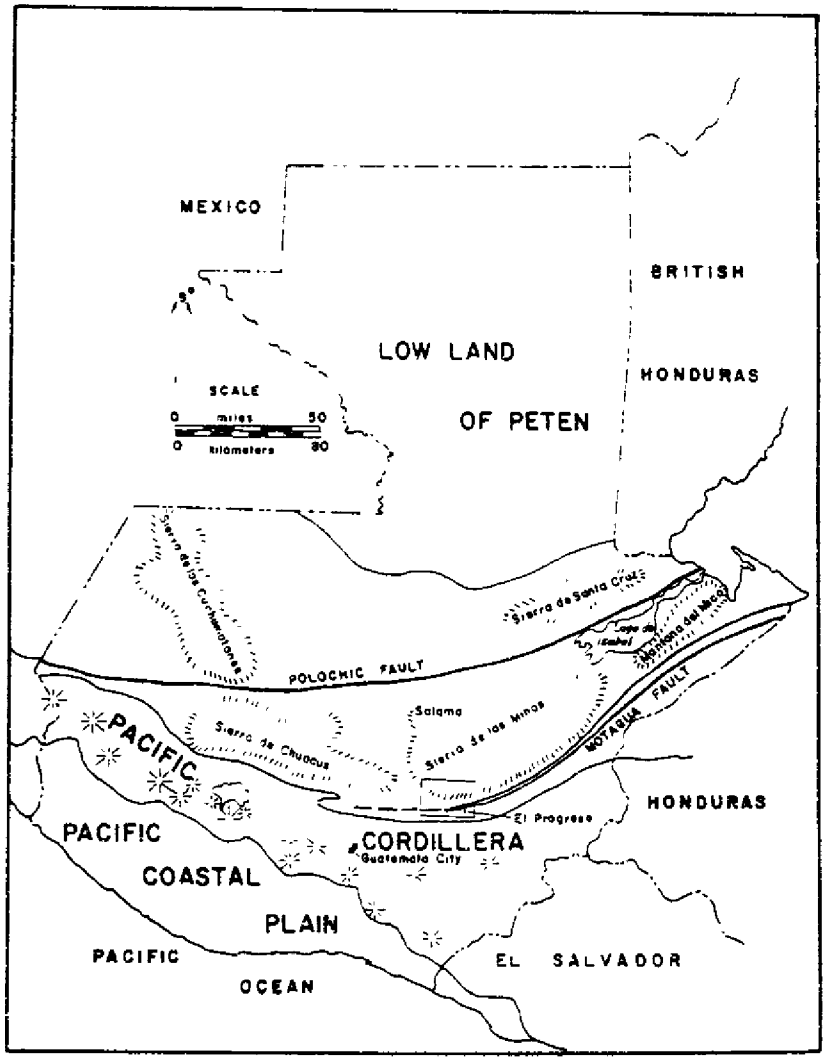
FIGURES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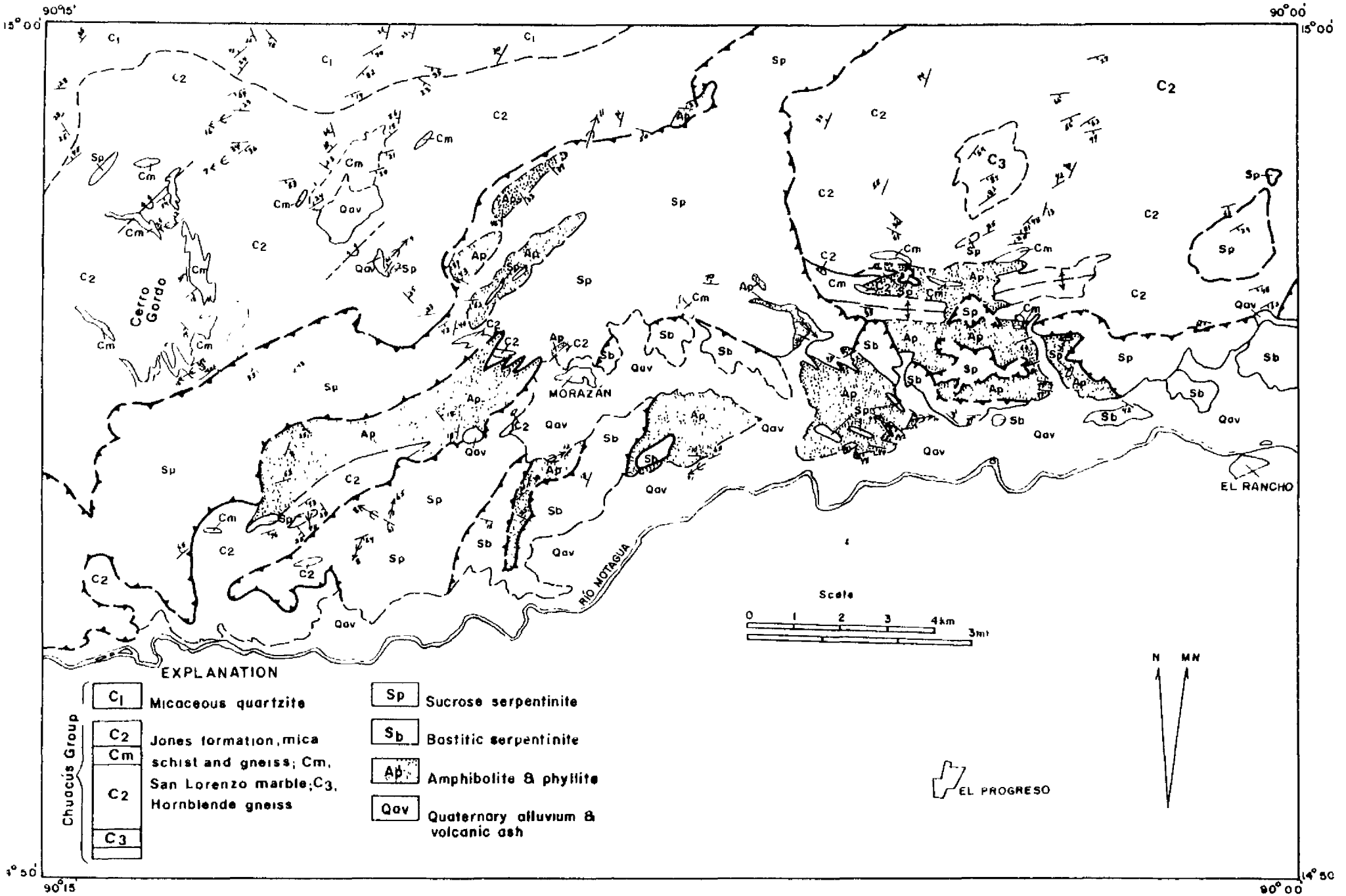
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EXPLANATION
Chuacús Group
C1 Micaceous quartzite
C2 Jones formation, mica schist and gneiss; Cm, San Lorenzo marble; C3, Hornblende gneiss
Cm
C2
C3
Sp Sucrose serpentinite
Sb Bastitic serpentinite
Ap Amphibolite & phyllite
Qav Quaternary alluvium & volcanic ash

PALEOZOIC DEFORMATION OF THE CHUACÚS GROUP IN THE SIERRA DE LAS MINAS RANGE, GUATEMALA

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ABSTRACT

At least three phases of approximately co-axial folding have been recognized in the southwestern end of the Sierra de las Minas range in Guatemala. F_1 isoclines are subhorizontal, F_2 folds are predominately overturned to the south, and F_3 is represented by open flexural-slip folds. Textural studies indicate that no significant recrystallization occurred during F_2 or F_3, suggesting that F_1, F_2, and F_3 represent three pulses of one orogenic event which probably occurred during the middle Paleozoic. Horizontal displacement by F_1 folding was greater than 1 mile, and therefore qualifies this structure as a nappe. This type of structure has been recognized along approximately 90 km. of the Sierra de las Minas range, suggesting that much, if not all, of the southern portion of this mountain range is an east-west trending refolded nappe.

INTRODUCTION

The purpose of this paper is to outline the nature and tectonic significance of Paleozoic deformation in the Chuacús Group in the southwestern part of the Sierra de las Minas range in Guatemala. Subsequent late Mesozoic and Tertiary tectonism of these rocks is beyond the scope of this report. However, it is necessary to be able to understand ancient structures in order to distinguish more clearly later structural events that are superimposed on these rocks.

King (1959) noted that the north-south trending Cordilleran orogen in western North America extends southward into Mexico. Burchfiel and Davis (1972; 1975) suggested that this trend may be partially disrupted by faulting in northern Mexico and Southern California. However, King (1959) and Kesler (1971) have shown that, near the border between Mexico and Guatemala, the Central American Cordillera makes a sharp eastward bend, and crosses Guatemala in an east-west direction, terminating in British Honduras, rather than continuing southeastwardly down the west side of Central America (Fig. 1). These ranges are characterized by complex metamorphic assemblages of pre-late Paleozoic rocks.

The location of the study area (Fig. 1 and 2) is in El Progreso quadrangle on the southwestern side of the Sierra de las Minas range. Earlier reconnaissance studies in this vicinity by McBirney (1963) and Bosc (1971), unpublished) had significant discrepancies between them. These conflicting views justified a re-evaluation of this region in 1971 by the author. In addition to this study Newcomb (1975) mapped the San Agustín Acasaguastlán quadrangle to the east of El Progreso and the Río Hondo quadrangle to the northeast of the San Agustín quadrangle along the southern side of the Sierra de las Minas range. These studies indicate that this mountain system is composed chiefly of a complex group of metasedimentary and metaigneous rocks which are collectively known as the Chuacús Group.

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