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Carboniferous Stratigraphic Analysis in the Subandean Foothills and the Chaco Plains of Tarija Basin-Bolivia.

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According to well data, outcrops and 2D and 3D seismic information, a regional sequential stratigraphic analysis is developed for the Carboniferous Interval of the Southwest sector of the Tarija Basin.

The area of study lies between Santa Cruz de la Sierra to the North, the Charagua, Aguarague and Parabanon ranges to the West, the Pilcomayo River to the South and the Chaco Plains to the East. (Figure 1).

The Carboniferous depositional cycle lasts approximately 74 million years. Its deposits are influenced in part by glaciation.

The distribution of the sedimentary infilling is directly related to the advance or retreat of the glaciers and to the eustatic variations and the accommodation space generated.

The base of the Carboniferous is an important erosive unconformity generated on the Devonian age deposits corresponding to the Iquiri Fm. The top is an erosive unconformity showing a very important paleoclimatic change represented by Permian eolian sediments belonging to the Cangapi Frn.

Based on seismic interpretation two Megasequences have been defined. The limit between them is a regional erosive unconformity characterized by the development of important paleovalleys. These paleovalleys indicate the major advance of the glaciar systems during the Carboniferous.

It is assumed that this unconformity corresponds in age to the Mississippian Pennsylvanian limit.

The lower Megasequence, of Mississippian age, shows marine influence by the association of facies defined in outcrops, especially in its early stage. For the Upper Megasequence, of Pennsylvanian age, continental environments prevail.

Seismically interpreted, erosive limits allow the subdivision of these two Megasequences in two sequences of third-order respectively. (Figure 2).

Each one of the four defined sequences (SSQI, SSQ2, SSQA and SSQB) is formed by deposits corresponding to the development of the Lowstand system tract and the Transgressive system tract .

The basal section of each sequence comprises deposits of subaerial and subaqueous outwash and deltaic deposits, which are lithologically represented by diamictites, sandstones and shales eventually.

The top section of each sequence represents the infilling of these eroded paleovalleys plus the flood plain deposits. Lithologically these are represented by sandstones and shales. (Figure 3).

Due to reworking of the top sediments of each one of the sequences the preservation potential of the transgressive system tract is low. However, in the area of the study those corresponding to SSQI and SSQB are preserved, and can be regionally correlated. In accordance with our work they would correspond to the maximum flooding surface during the Carboniferous, (SSQI), and to the flooding of the depositional system on reaching the equilibrium profile,(SSQB).

The limits of each one of the sequences could be defined in outcrops and wells. Their geometry has been adjusted using seismic interpretation.

The integration of these data enables us to determine the paleogeography of each one of the Sequences.

Based on the result of this analysis the source for all the Carboniferous deposits could be seen to come from an Easterly or Southeasterly direction with the depocenter of the basin developed toward the North and Northwest of the study area. In general an increase in the shale content for each sequence can be observed as one moves in a North or Northwesterly direction. (Figure 4).

The different cycles studied here have been matched to the classic stratigraphic units of the Tarija Basin.

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Figure 1

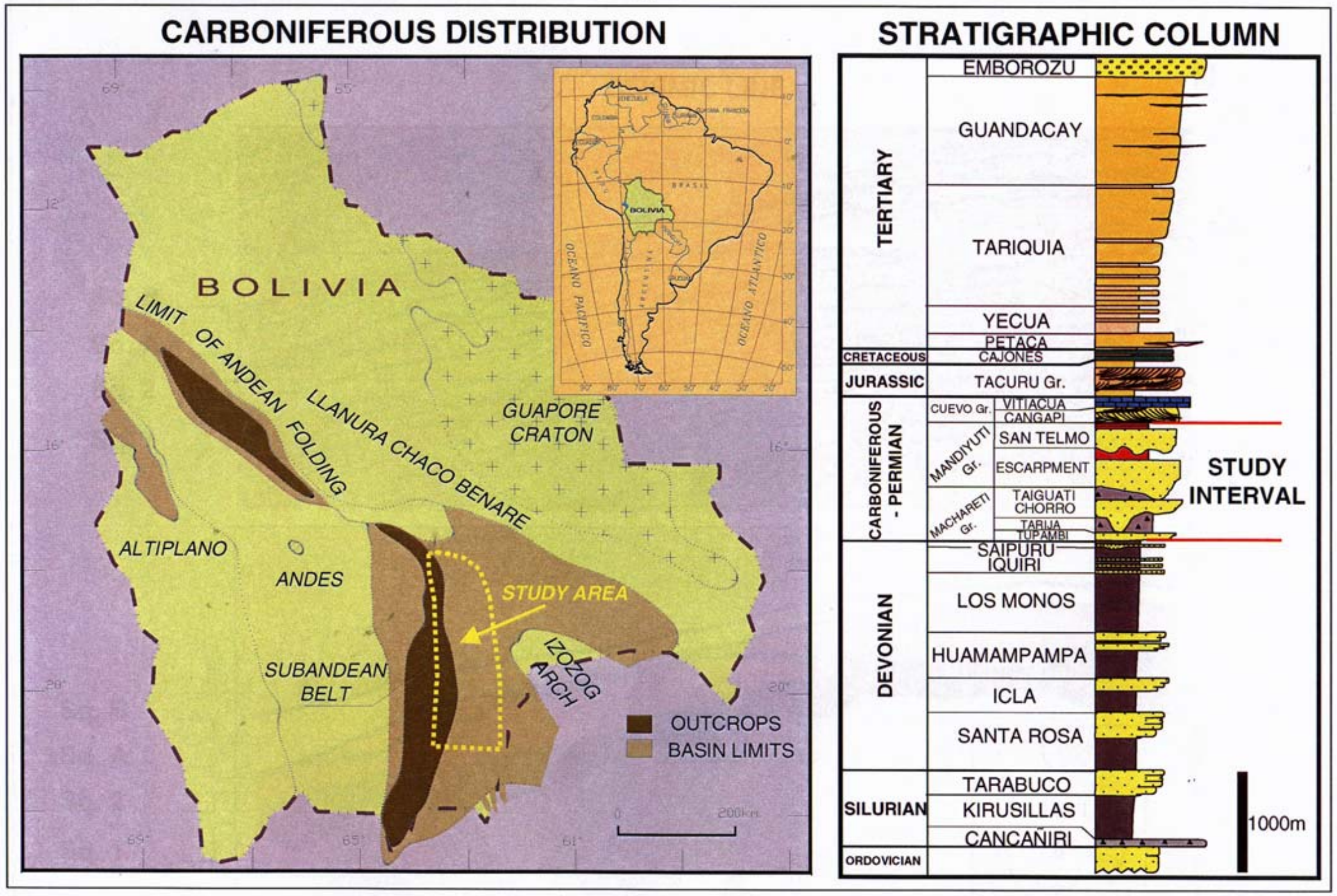

CARBONIFEROUS DISTRIBUTION
BOLIVIA
LIMIT OF ANDEAN FOLDING
LLANURA CHACO BENARE
GUAPORE CRATON
ALTIPLANO
ANDES
SUBANDEAN BELT
STUDY AREA
IZOZOG ARCH
OUTCROPS
BASIN LIMITS
OCEANO PACIFICO
OCEANO ATLANTICO
BOLIVIA
BRASIL
STRATIGRAPHIC COLUMN
TERTIARY
CRETACEOUS
JURASSIC
CARBONIFEROUS - PERMIAN
DEVONIAN
SILURIAN
ORDOVICIAN
EMBOROZU
GUANDACAY
TARIQUIA
YECUA
PETACA
CAJONES
TACURU Gr.
CUEVO Gr.
VITIACUA
CANGAPI
MANDIYUTI Gr.
SAN TELMO
ESCARPMENT
MACHARETI Gr.
TAIGUATI
CHORRO
TARIJA
TUPAMBI
SAIPURU
IQUIRI
LOS MONOS
HUAMAMPAMPA
ICLA
SANTA ROSA
TARABUCO
KIRUSILLAS
CANCAÑIRI
STUDY INTERVAL
1000m

Figure 2 - DEPOSITIONAL SEQUENCES

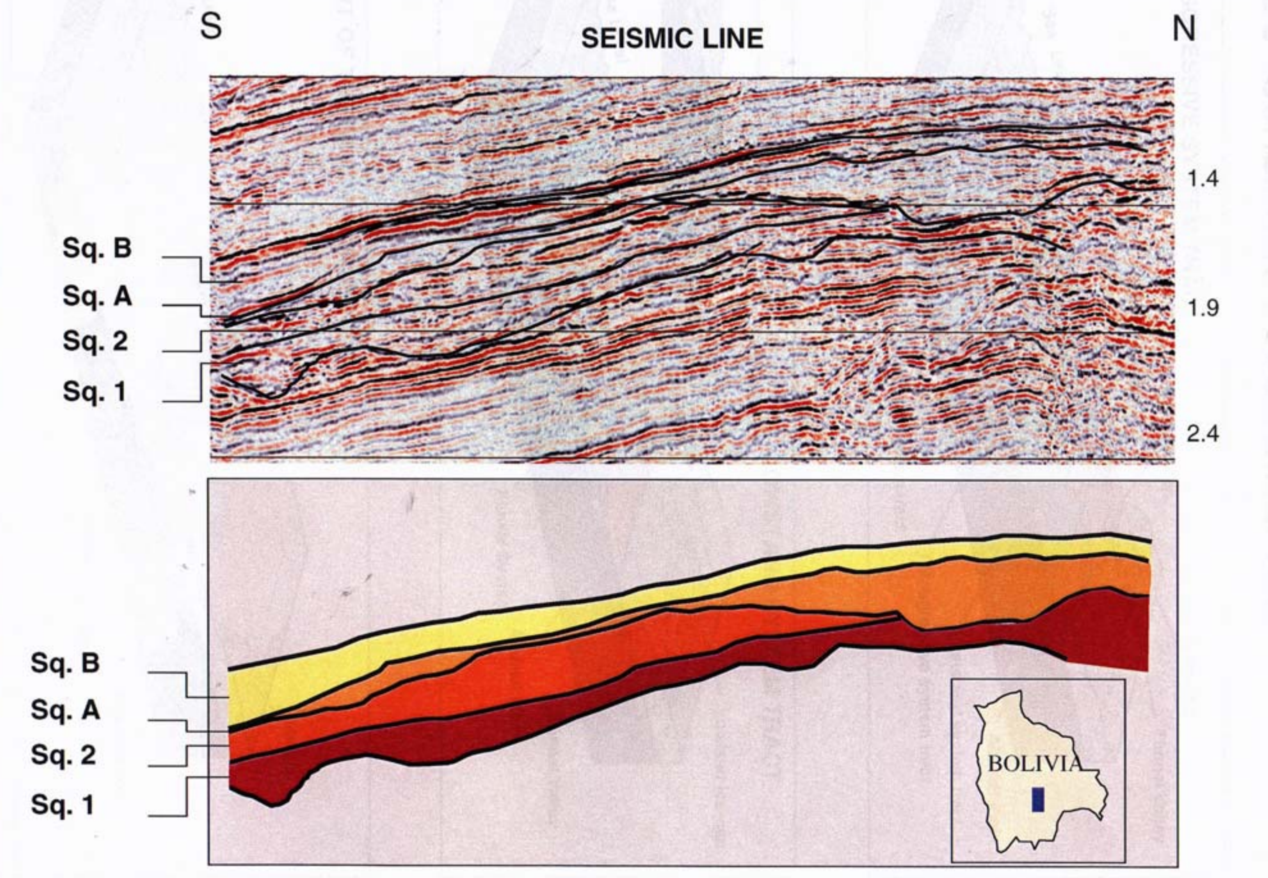
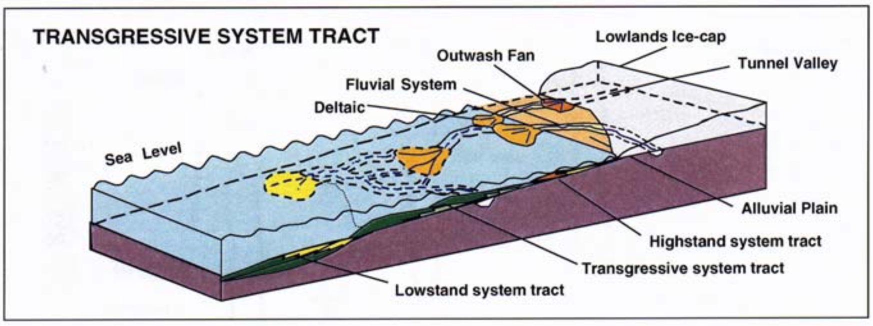
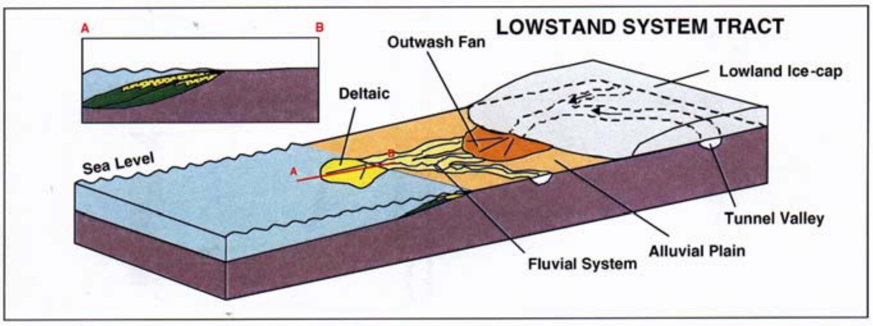


Figure 3 - SCHEMATIC BLOCK DIAGRAMS





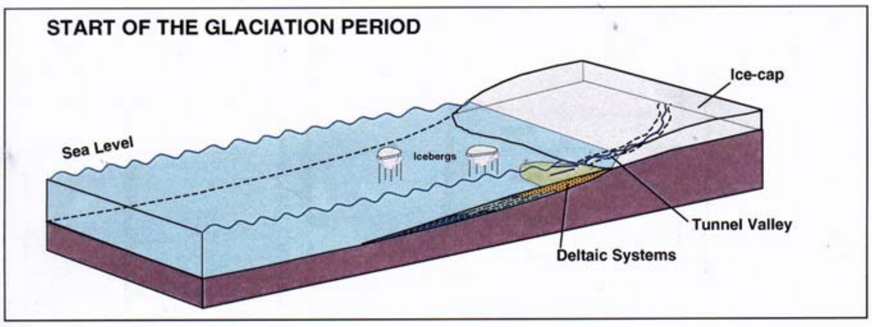
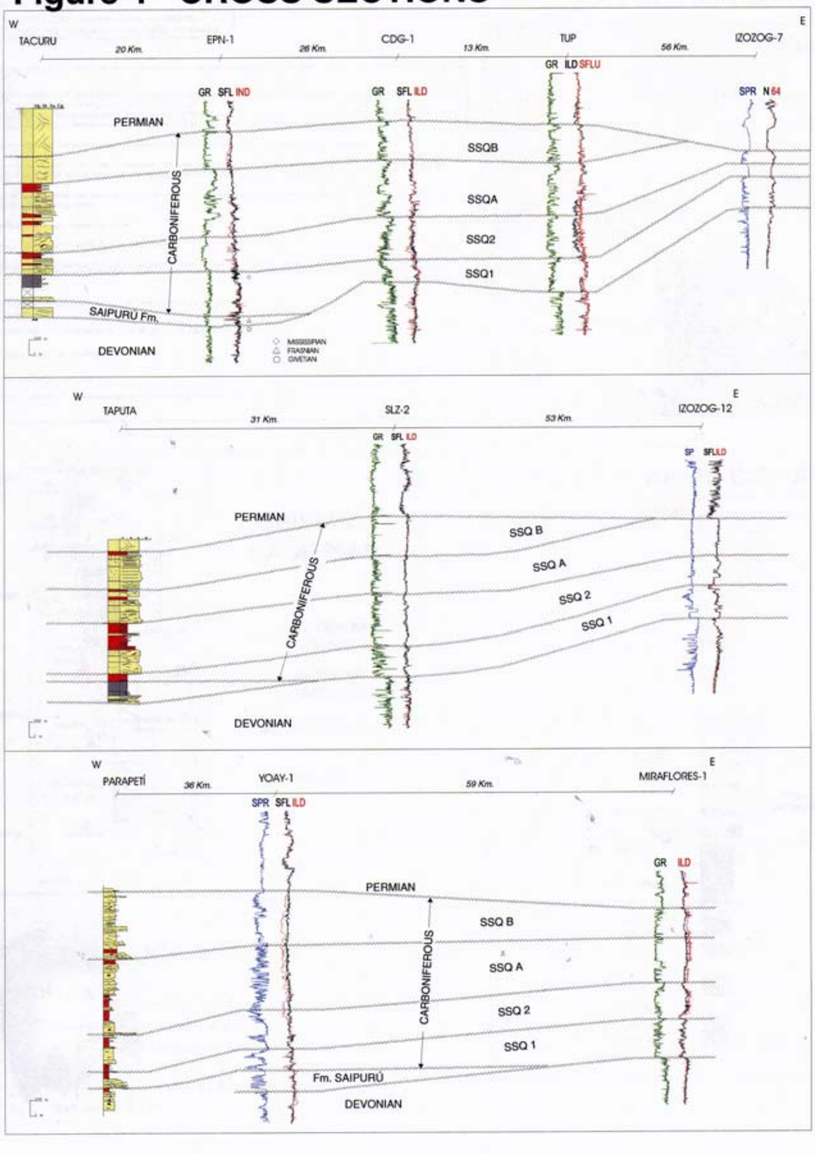


Figure 4 - CROSS SECTIONS



pluspetrol

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ABSTRACT:

Based on 3D and 2D seismic and supported by outcrops and well-log information, a seismic stratigraphic analysis was performed on the Carboniferous interval over a large part of the Tarija Basin.
This area is located between Santa Cruz de la Sierra to the north and the Pilcomayo river to the south, and it is bounded by the outcrops of the Aguarague, Charagua and Parabanon Ranges to the west and the Bolivian Chaco to the east.

Four Carboniferous depositional sequences and their bounding by erosional surfaces have been identified.

Each sedimentary cycle responds to relative sea level changes caused by the inter-relationship between the velocity of global eustatic variation, the advance or retreat of glacier ice cap and the isostatic response due to this ice cap variation.

The lower cycles of Mississipian age show marine influence in the outcrops, while in the two upper Pennsylvanian cycles a continental environment is dominant.

Both are related to peripherical glacial position.

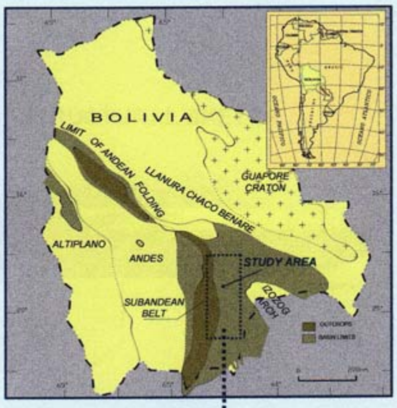
A basin-fill model is proposed for each defined sequence.

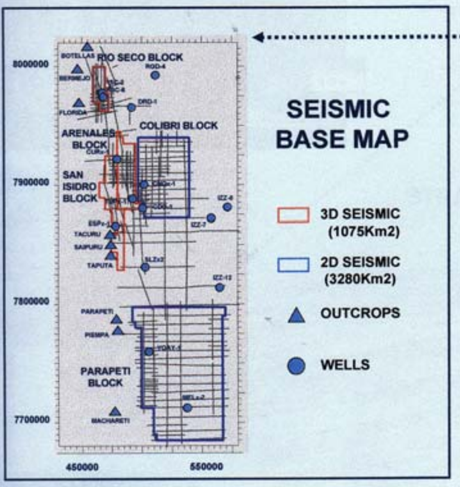
The different sequences here defined, for each geographic position, are related to the classical formation units of the Tarija Basin.

OBJECTIVES:

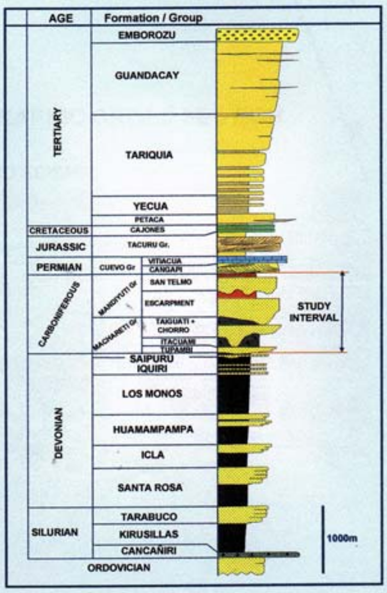
- To define the depositional sequences and determine their architecture.
- To establish a subsurface to surface correlation.
- To determine the paleogeography.

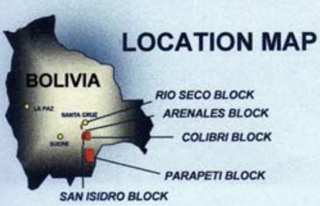
CARBONIFEROUS DISTRIBUTION

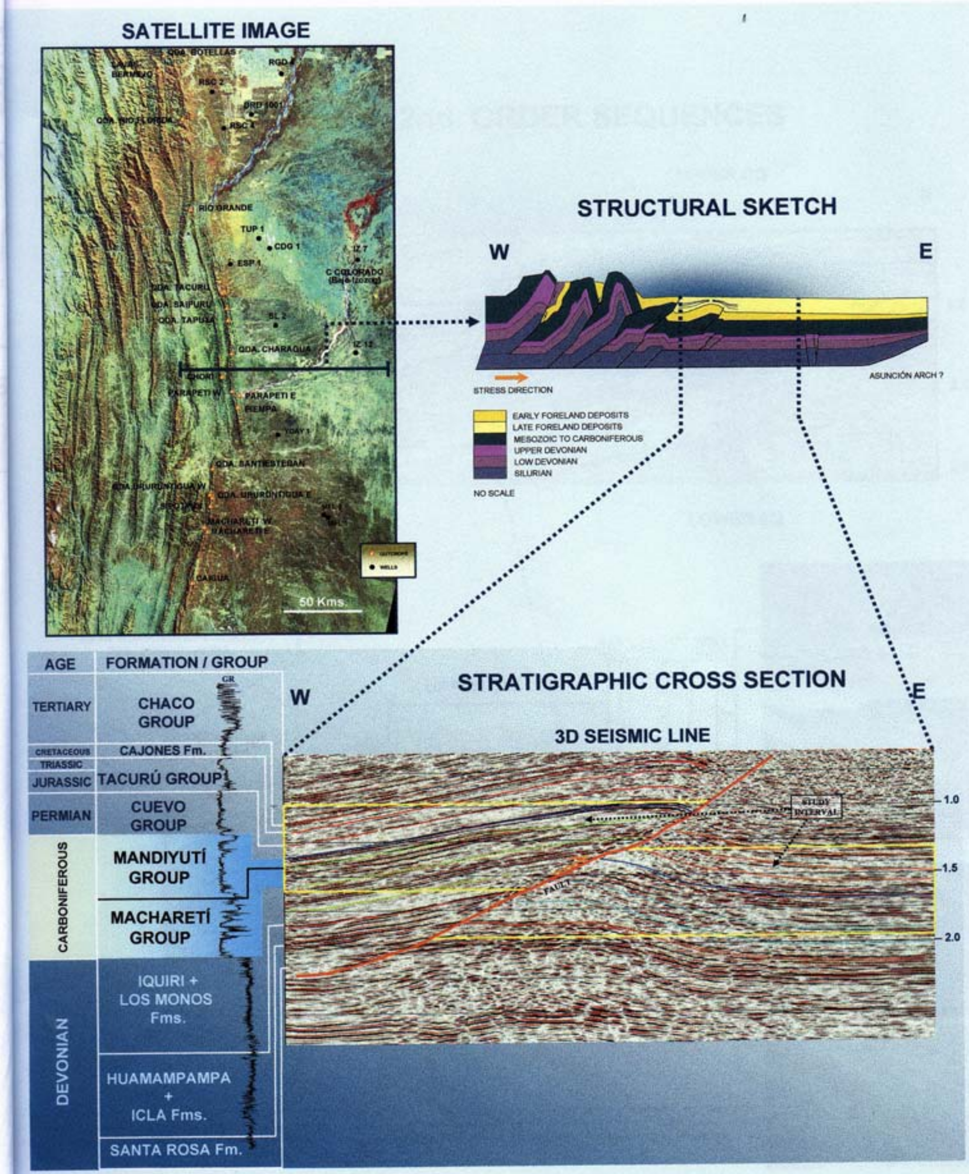




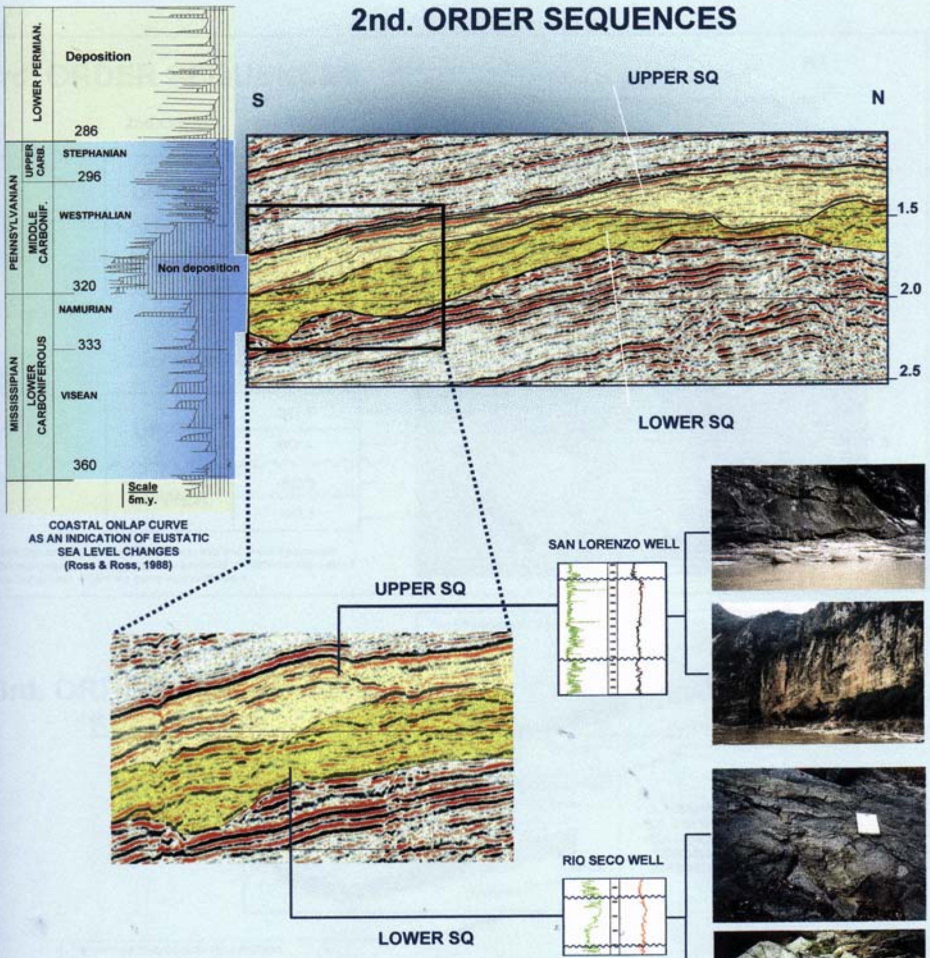
STRATIGRAPHIC COLUMN





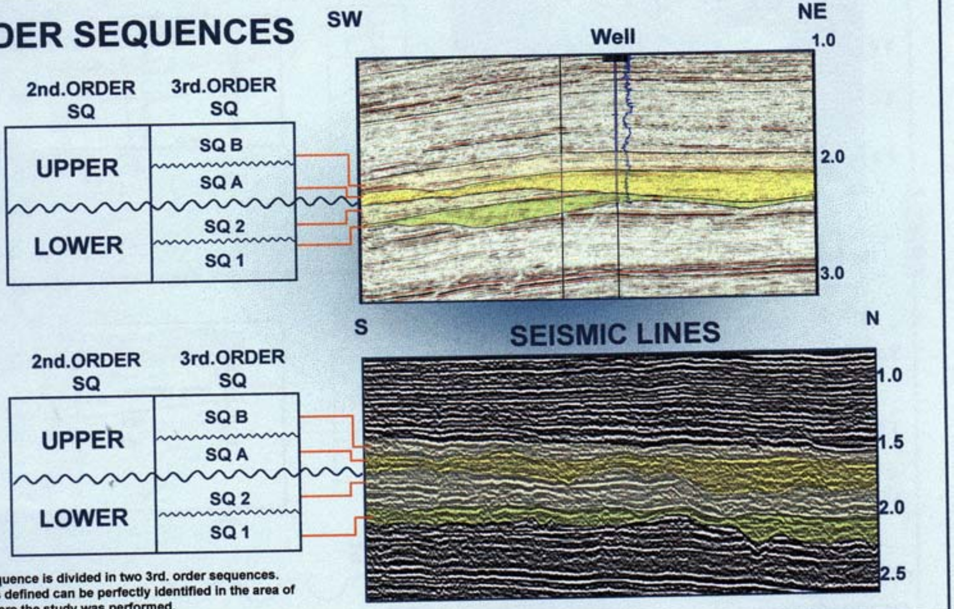

SATELLITE IMAGE
RIO GRANDE
TUP 1
CDG 1
ESP 1
GDA. CHARAGUA
PARAPETI E
GDA. SANTIESTEBAN
GDA. IRUNDIGUA E
CAIGUA
50 Kms.
STRUCTURAL SKETCH
W
E
STRESS DIRECTION
ASUNCIÓN ARCH ?
EARLY FORELAND DEPOSITS
LATE FORELAND DEPOSITS
MESOZOIC TO CARBONIFEROUS
UPPER DEVONIAN
LOW DEVONIAN
SILURIAN
NO SCALE
AGE
FORMATION / GROUP
GR
TERTIARY
CHACO GROUP
CRETACEOUS
CAJONES Fm.
TRIASSIC
JURASSIC
TACURÚ GROUP
PERMIAN
CUEVO GROUP
CARBONIFEROUS
MANDIYUTÍ GROUP
MACHARETÍ GROUP
DEVONIAN
IQUIRI + LOS MONOS Fms.
HUAMAMPAMPA + ICLA Fms.
SANTA ROSA Fm.
STRATIGRAPHIC CROSS SECTION
W
E
3D SEISMIC LINE
STUDY INTERVAL
FAULT
1.0
1.5
2.0

2nd. ORDER SEQUENCES



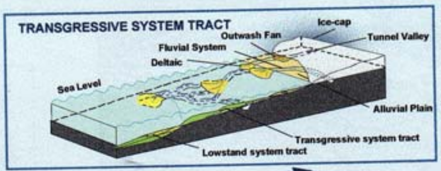
- Two 2nd. order sequences are defined in the Carboniferous interval as a result of the big erosive unconformity observed in the seismic.
- With regards to the coastal onlap curve this unconformity corresponds to the Missisipian - Pennsylvanian limit (non depositional period).
- Conglomerate and diamictite are predominant in the basal sequence while sandstones are the main lithology in the upper sequences.

3rd. ORDER SEQUENCES

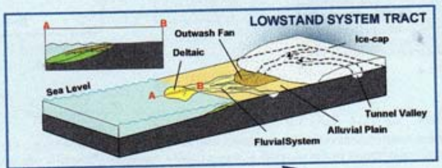


- Each 2nd. order sequence is divided in two 3rd. order sequences.
- The four sequences defined can be perfectly identified in the area of the Tarija basin where the study was performed.

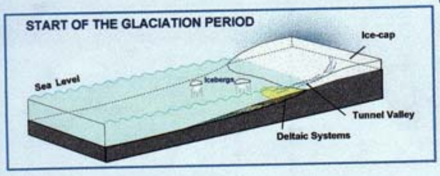
3rd. ORDER SEQUENCES EVOLUTION



- GLACIAL RETREAT.
- SEA LEVEL RISES.



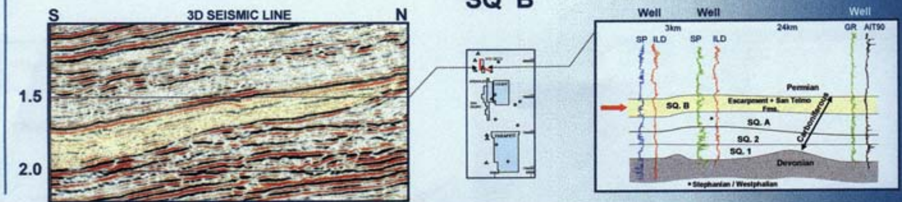
- GLACIAL PERIOD.
- ICE CAP RETAINED WATER.
- SEA LEVEL STARTED TO FALL.
- OUTWASH FANS GRADE INTO LARGE BRAIDED RIVERS.



DURING CARBONIFEROUS AGE, IN GONDWANA, THE GLACIATION WAS A VERY IMPORTAT FACTOR IN SEA LEVEL CHANGE AND SEDIMENT SUPPLY.

UPPER

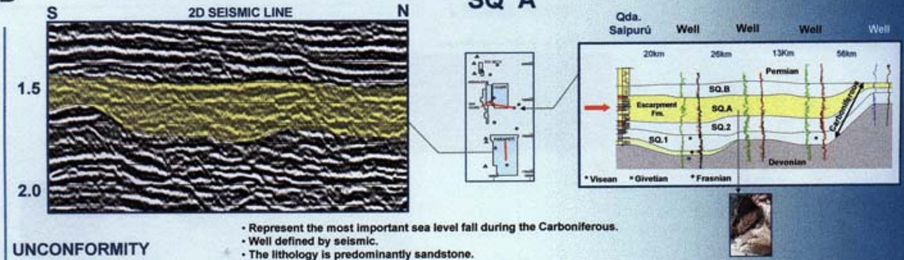
SQ B



- Deposits correspond to the infilling of paleovalleys generated during a sea level fall.
- The upper part corresponds to red shales and to lesser degree reddish-brown sandstones.

UNCONFORMITY

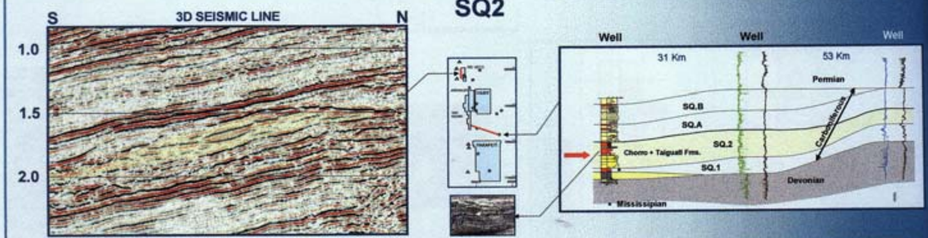
SQ A



- Represent the most important sea level fall during the Carboniferous.
- Well defined by seismic.
- The lithology is predominantly sandstone.

UNCONFORMITY

SQ2

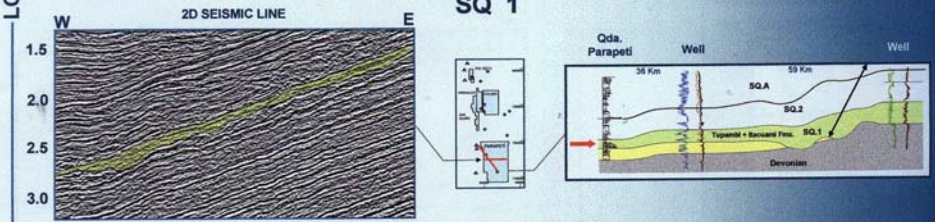


- In the eastern sector the lithofacies in the wells are mainly sandstones while towards the west the shale contents is important.

UNCONFORMITY

LOWER

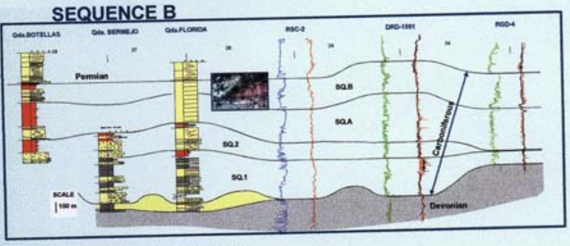
SQ 1



- The beginning of the SQ1 is related to an important sea level fall.
- The geometry shows the development of a paleovalley system.
- The top is represented in seismic by parallel reflectors with large areal continuity(flooding episode).
- It may be the maximum flooding during the Carboniferous.

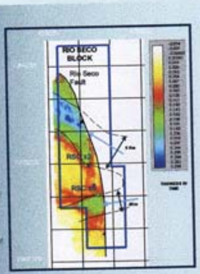
PALEOGEOGRAPHIES

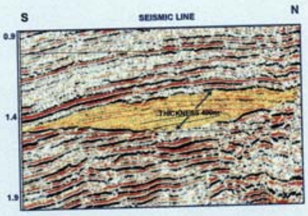
SEQUENCE B



• The distal facies are present in the western and northern part of the study area.

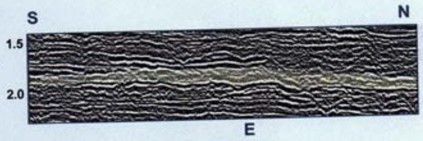
SEQUENCE A





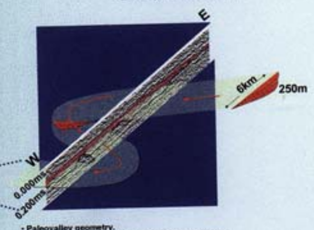
• A Paleovalley geometry is defined through out the study area .Important stack of massive sandstones

SEQUENCE 2



• A lobe geometry is defined - Outwash fan.

SEQUENCE 1



- Paleovalley geometry.
- The distal facies are developed in the western part.
- The paleoflows run from east to west.

CONCLUSIONS

- FOUR SEQUENCES IN THE CARBONIFEROUS INTERVAL WERE DEFINED.
- ALL THE DEPOSITS ARE GLACIALLY INFLUENCED.
- THE BEST RESERVOIRS CORRESPOND TO UPPER SEQUENCE.
- THE REGIONAL SEAL CORRESPONS TO THE MARINE SHALES FACIES (SQ1).
- WE CAN PREDICT IN A REGIONAL SENSE THE RESERVOIRS AND SEALS DISTRIBUTION FOR EACH SEQUENCE.