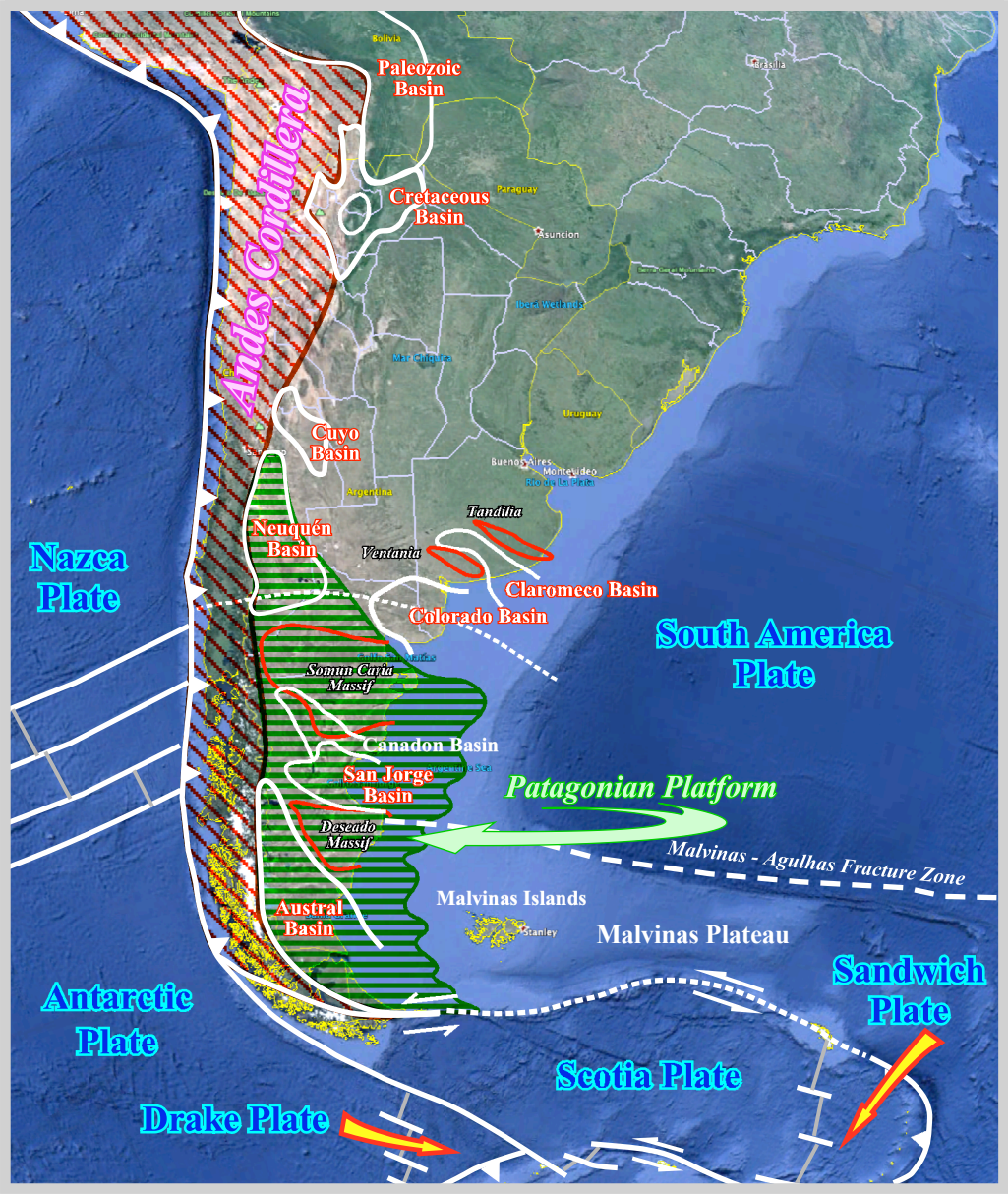
Argentina Sedimentary Basins

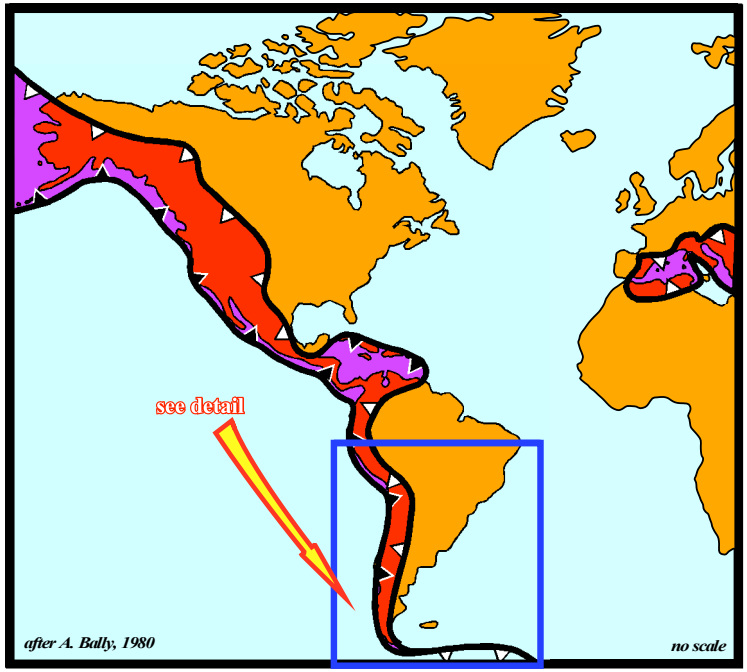
(Malvinas Geographic Basin)

CCramez, 2014

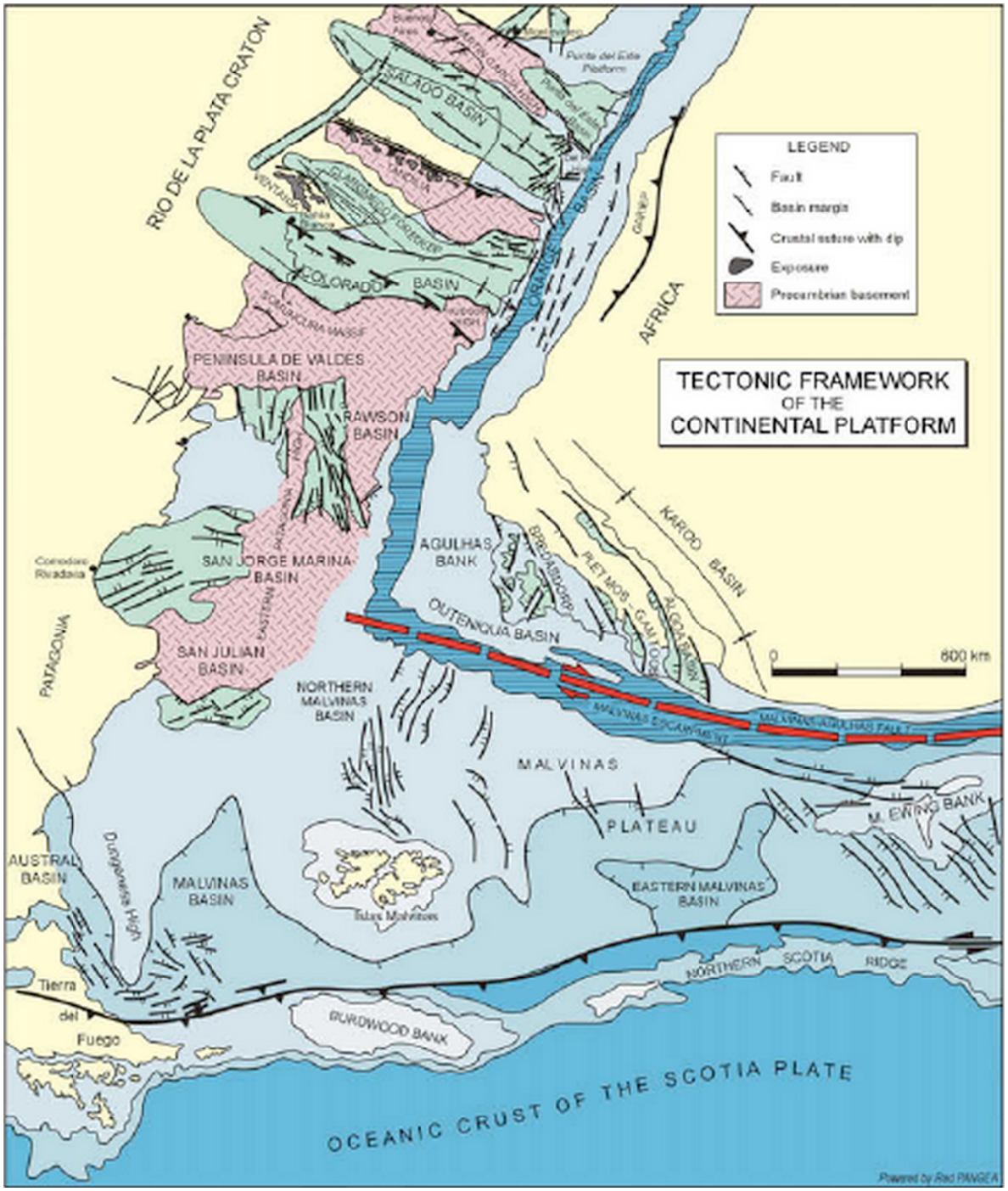
Regional Macrotectonic Features



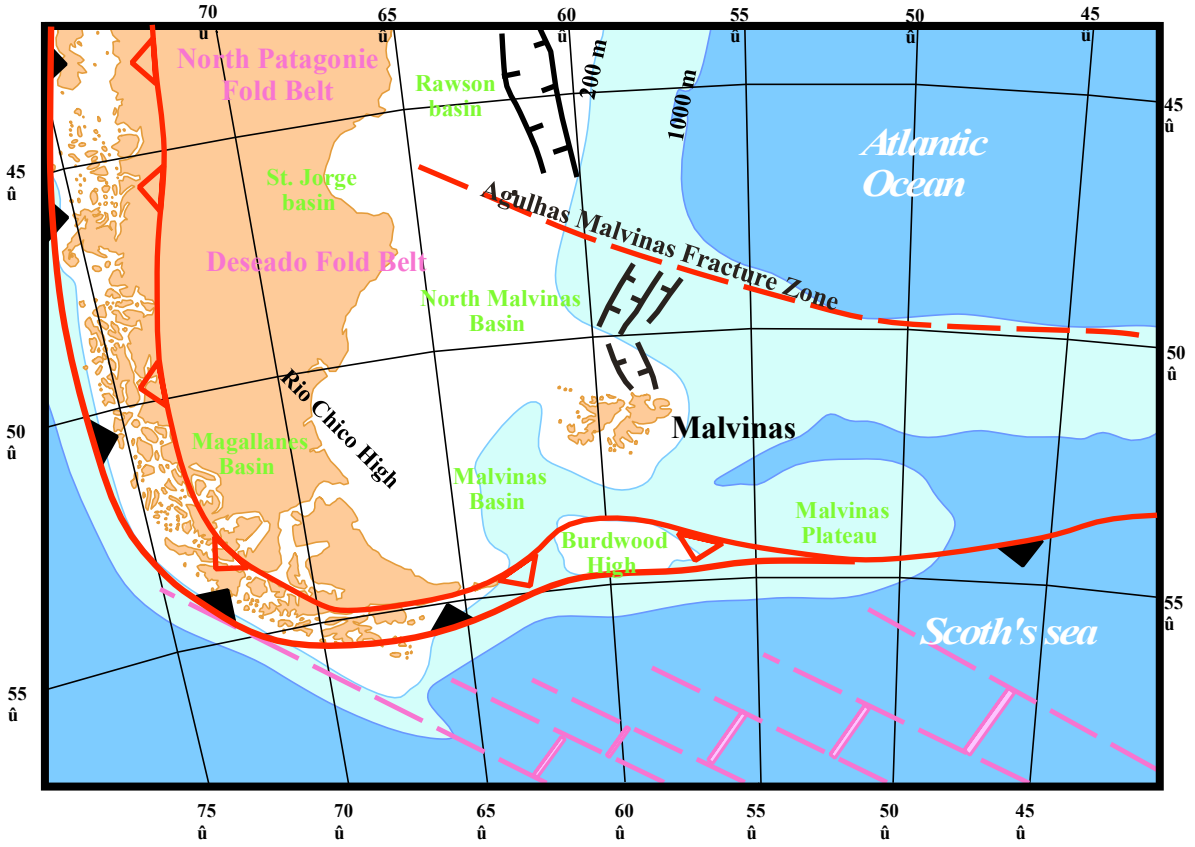
Meso-Cenozoic Megasuture



Subduction B (Benioff)
Subduction A (Ampferer)


RIO DE LA PLATA CRATON
SALADO BASIN
COLORADO BASIN
ORANGE BASIN
AFRICA
LEGEND
Fault
Basin margin
Crustal suture with dip
Exposure
Precambrian basement
TECTONIC FRAMEWORK
OF THE
CONTINENTAL PLATFORM
PENINSULA DE VALDES BASIN
RAWSON BASIN
SAN JORGE MARINA BASIN
SAN JULIAN BASIN
PATAGONIA
AGULHAS BANK
KAROO BASIN
OUTENIQUA BASIN
0
600 km
NORTHERN MALVINAS BASIN
MALVINAS
PLATEAU
M. EWING BANK
AUSTRAL BASIN
MALVINAS BASIN
EASTERN MALVINAS BASIN
NORTHERN SCOTIA RIDGE
Tierra del Fuego
BURDWOOD BANK
OCEANIC CRUST OF THE SCOTIA PLATE
Powered by Red PANGEA

Malvinas Archipelago & Surrounding Basins



Conclusions:

There is a high probability that an generating petroleum subsystem was developed in the northern basin of the Malvinas. However, the chances of economic accumulation seem to be quite low. The closures of the potential traps proposed by Shell (prospect A and B) are doubtful. Prospect A does not have a clean four way dip. The potential reservoirs are oblique to the mapped interfaces (unconformity associated with the continental breakup and maximum flooding surface). The proposed closure for prospect B is only valid if the potential reservoirs are coalescing, which may not be the case. We must try to refute the proposed closures by a exhaustive seismic interpretation, which has not been done.

I- Introduction

Despite the fact that the regional geological context of the northern basin of the Malvinas is, relatively, poorly known (no control wells), the global context (plate tectonics), the interpretation of the seismic lines made available to us and the fruitful discussions I had with several geoscientists working in the area, allow us to put forward some hypotheses on potential petroleum systems.

II- Global Context

During the late Paleozoic, the deposit of the "Gondwana sequence" is characterized by very weak magmatic activity and strong sedimentary shortening (Pan African-Brazilian orogeny). The predominant structural alignments have a NNO-SSE orientation. Since the Triassic, the predominant tectonic regimes were extensive and the magmatic activity very intense. This change announces the beginning of the breakup of the Pangea southern continent, i.e., Gondwana. In fact, during this geological period, the lithosphere extended perpendicular to the Paleozoic structural alignments.

In response to this stretching, half-grabens and grabens oriented N 150-160° formed. They were filled, in large part, by volcano-clastic sediments intercalated with lacustrine sediments. The amount of volcanic material decreases upward. During the Jurassic, the western and southern margins of South America were surrounded by an imposing volcanic arc behind which back-arc basins developed. The volcanic arc and back-arc basins were induced by subduction of the Panthalassa oceanic crust. The majority of these basins have a NNO-SSE orientation. This orientation suggests the extension of the continental crust, behind the volcanic arc, was made by reactivation of the old normal faults delimiting the Triassic rift-type basins.

Subsequently, about 25 million years (Upper Jurassic) before the separation of South America and Africa by the emplacement of the volcanic crust (subaerial and oceanic), a further stretch of the lithosphere has taken place. It was marked by a fault system that allowed the formation of the Orange, Salado, Pelotas, Walvis and Santos geographic basins, etc. Another area, associated with this stretching, is underlined by the basins of Rawson, West Colorado, Macachin, Laboulade, North Malvinas, etc. Several geoscientists believe that these basins were, in large part, controlled by the Rio de la Plata and Agulhas - Malvinas fault zones.

n the Early Cretaceous, before the start of oceanic expansion between South America and Africa, extensive stretching and fracturing of the crust took place along the Atlantic margin of Argentina, Uruguay and SE from Brazil. The fracturation was particularly important along the Agulhas / Malvinas and Rio Grande / Walvis alignments. The associated rift-type basins, although oriented, locally, perpendicular to the Atlantic opening, are direct indicators of continental separation.

3D 448 Seismic Line

The 3D - 448 seismic line me allows to schematize the petroleum potential of this part of the North Malvinas offshore. On the proposed interpretation I make a few assumptions about the prospects that Shell has offered in lease. The illustrated interpretation is highly speculative. IThere are no exploration wells on the northern offshore of the Malvinas Basin. The geological calibration is mainly based on the global geological context. Significant changes are possible. Despite this, it seems to me that the following geological bodies are quite visible

- **A Paleozoic substratum ;**
- **A Rift-type basin associated with two stretching phases:**
  - **a) The earliest has an Upper Jurassic age and**
  - **b) The second one has a Lower Cretaceous age.**
- **The tectonically enhanced unconformity ("breakup unconformity") associated with the breakup of the continental crust;**
- **A divergent Meso-Cenozoic margin in which we must distinguish:**

  a) The transgressive phase of the continental encroachment cycle which is limited at the top by the downlap surface of the Lower Turonian (MFS 91.5 Ma), and
  b) The regressive phase which is, mainly, composed by sediments from the Upper Cretaceous and, above all, Tertiary.

Potential Petroleum Systems

The previous interpretation does not refute the presence of a generating petroleum subsystem in rift-type basins. This subsystem may have developed either in association with the Upper Jurassic stretching or with that of the Lower Cretaceous.

From seismic data and discussions with several geoscientists, the geometric relationships between reflectors and the internal configuration of the interval SB. 160 Ma - SB. 135 Ma, suggest the filling of a deep lake by downlapping of a "fan delta" ; The terrigeneous influx would b , occasionally , discharged into a lake by floods. In this hypothesis, the margins and the proximal parts of the lake would be filled by a lateral succession of:

(i) Alluvial fans ;
(ii) Lacustrine fan deltas ;
(iii) Distal shales.

The deep and central parts of the lake, where the autochthonous living organic matter would be more important, would have been filled with sediment from different sources. Under such conditions, the most likely generating petroleum subsystem would be of the Lower Cretaceous age. In this case, the important question is whether the organic material has been buried enough for it to reach maturity. The two prospects Shell offers to farmout are considered to be structural, i.e., with a four-way-dip closure. However, in my opinion, they are not.

In both cases, the reservoirs are oblique at the mapped interfaces and isolated from each other:

a) In prospect A, the reservoirs correspond to the toplaps of the progradation of the lowstand prograding wedge that can be seen above the unconformity associated with the breakup of the lithosphere (SB. 130 Ma) on which we see, locally, incised valleys.

b) In prospect B, the reservoirs are located below the uncoinformity (SB. 135 Ma). They are associated with the top of the toplaps of the delta fan progradations and may not be coalescing.

The amplitude of these progradations, in other words, the difference (in depth) between the two slope breaks, proximal and distal, exceeds 200 meters, and excludes conventional deltaic sedimentation.The regional coverage of potential petroleum systems is underlined by the Upper Cretaceous transgressive clays which fossilize the unconformity associated with the breakup of the lithosphere.

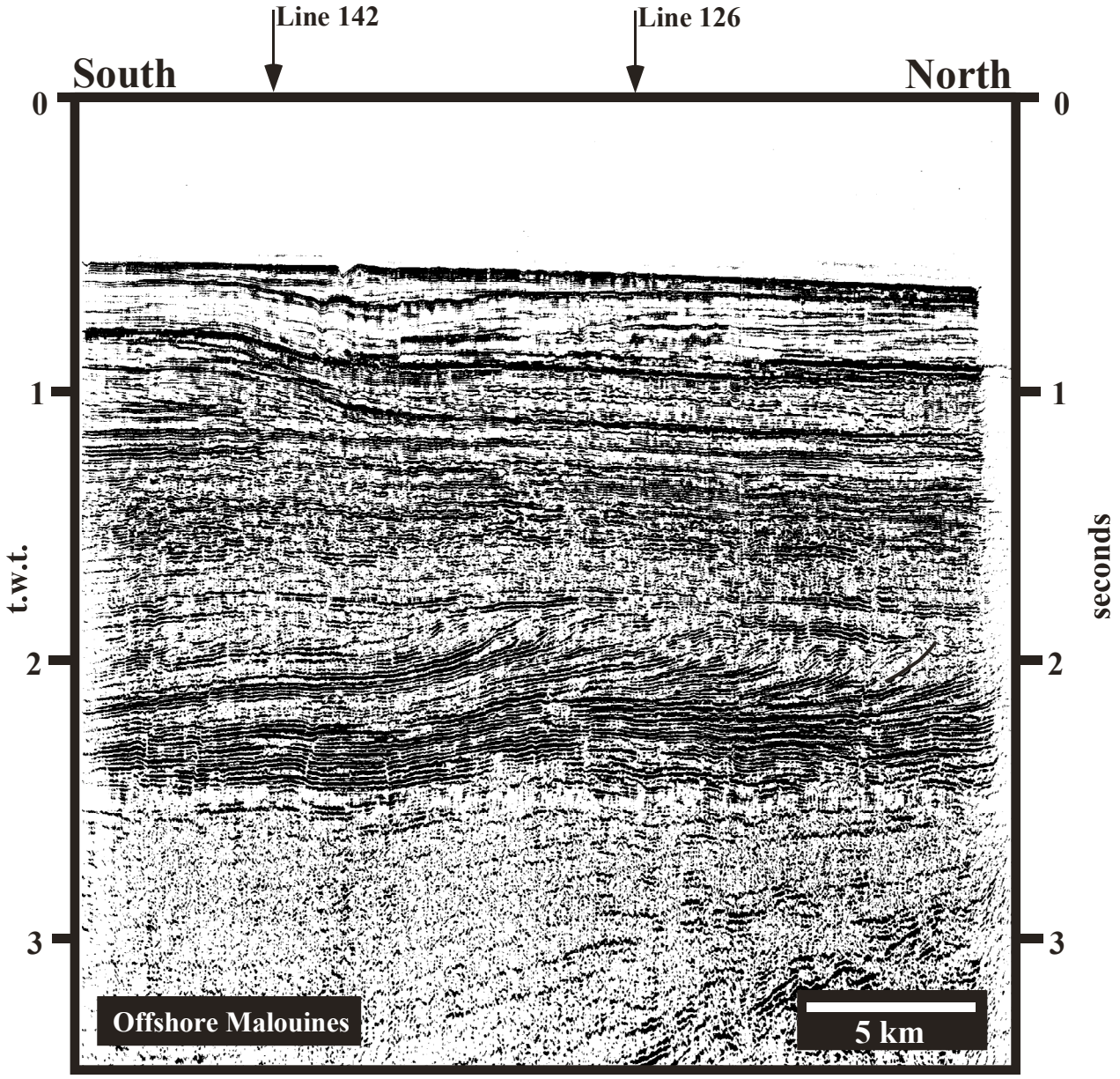
However, for prospect B, whose reservoirs are underlying the unconformity SB. 135 Ma, the presence of incised valleys penalizes the cover because the filling of these valleys seems to have a sandstone facies, i.e., there is a risk of leakage.

The cartographic closures linked to the unconformity associated with the breakup of the lithosphere and the downlap surface (Turonian) are quite large. Unfortunately, they are no significative. The geometry of the potential reservoirs does not seem to conform to the mapped interfaces.

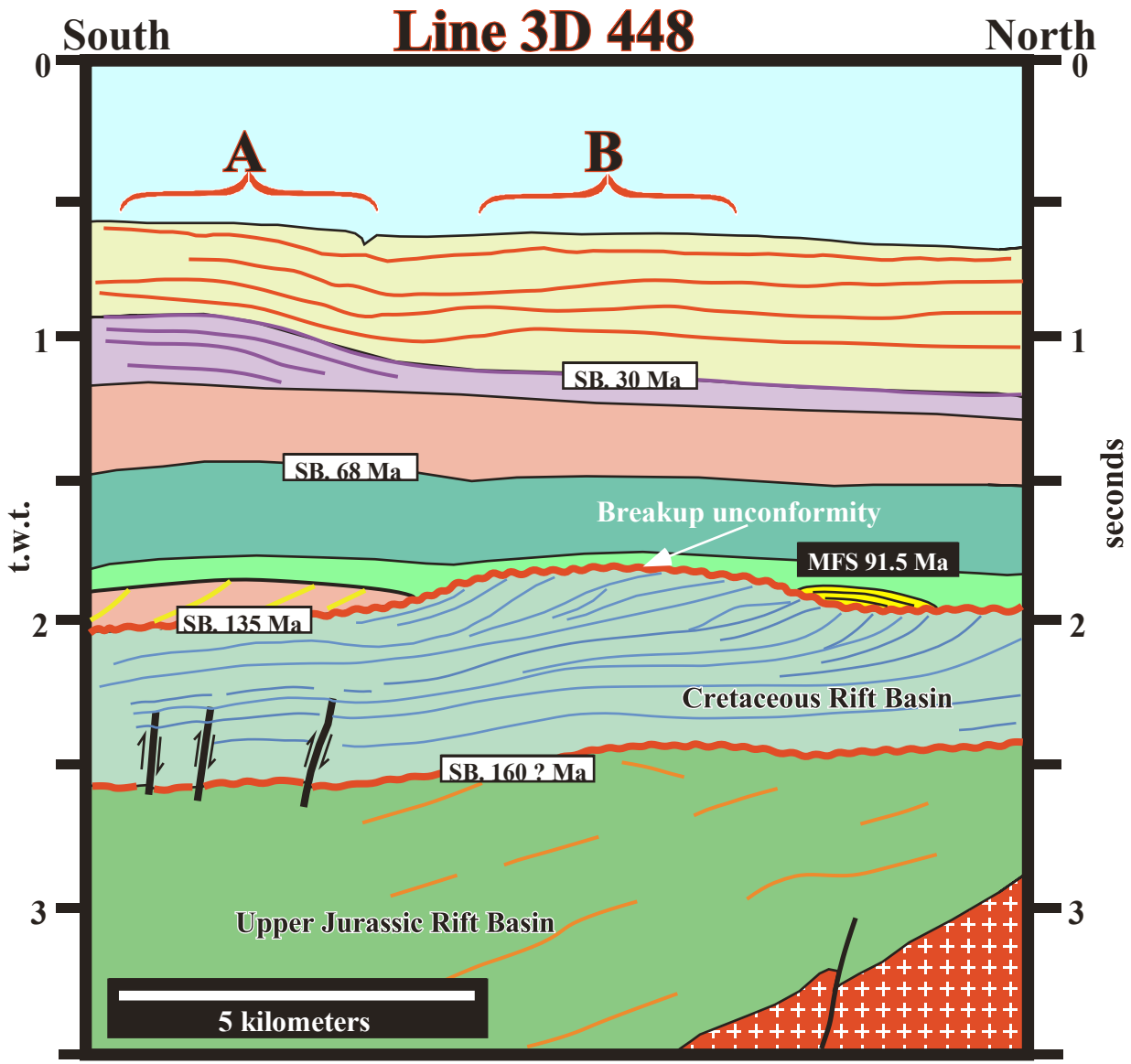
In conclusion:

I am not excluding the possibility of a generating petroleum subsystem, particularly in what I have interpreted as a Lower Cretaceous rift-type basin. However, it seems to me that the trapping mechanism is not well defined. They must be tested before making any decision.

Line 448

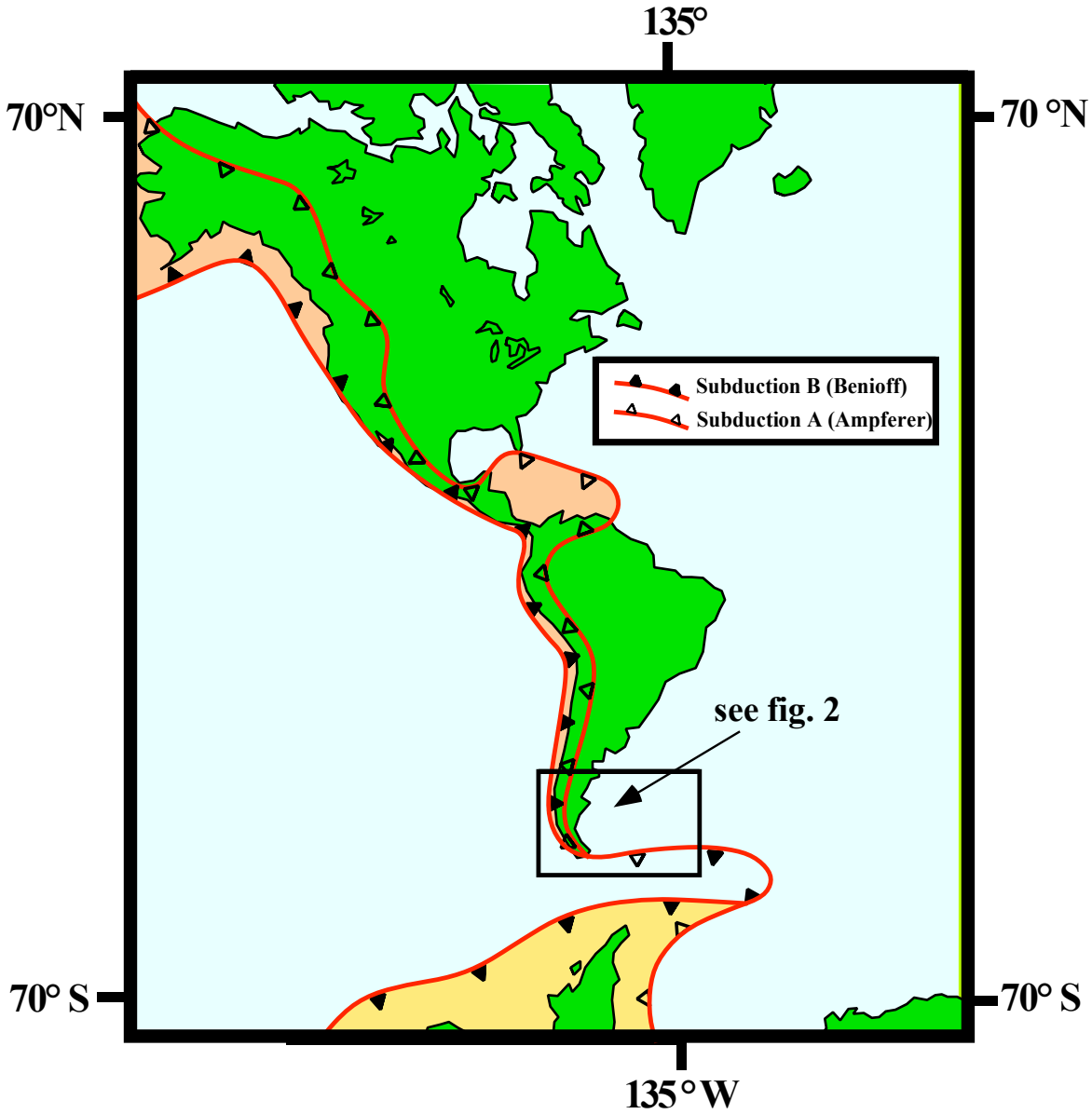


This seismic line, which geological interpretation of which is proposed in next plate, shows that the breakup of the continental crust is underlined by an unconformity marked by incised valleys, onlaps and downlaps. By correlation, we think his age is around 135 million years old.



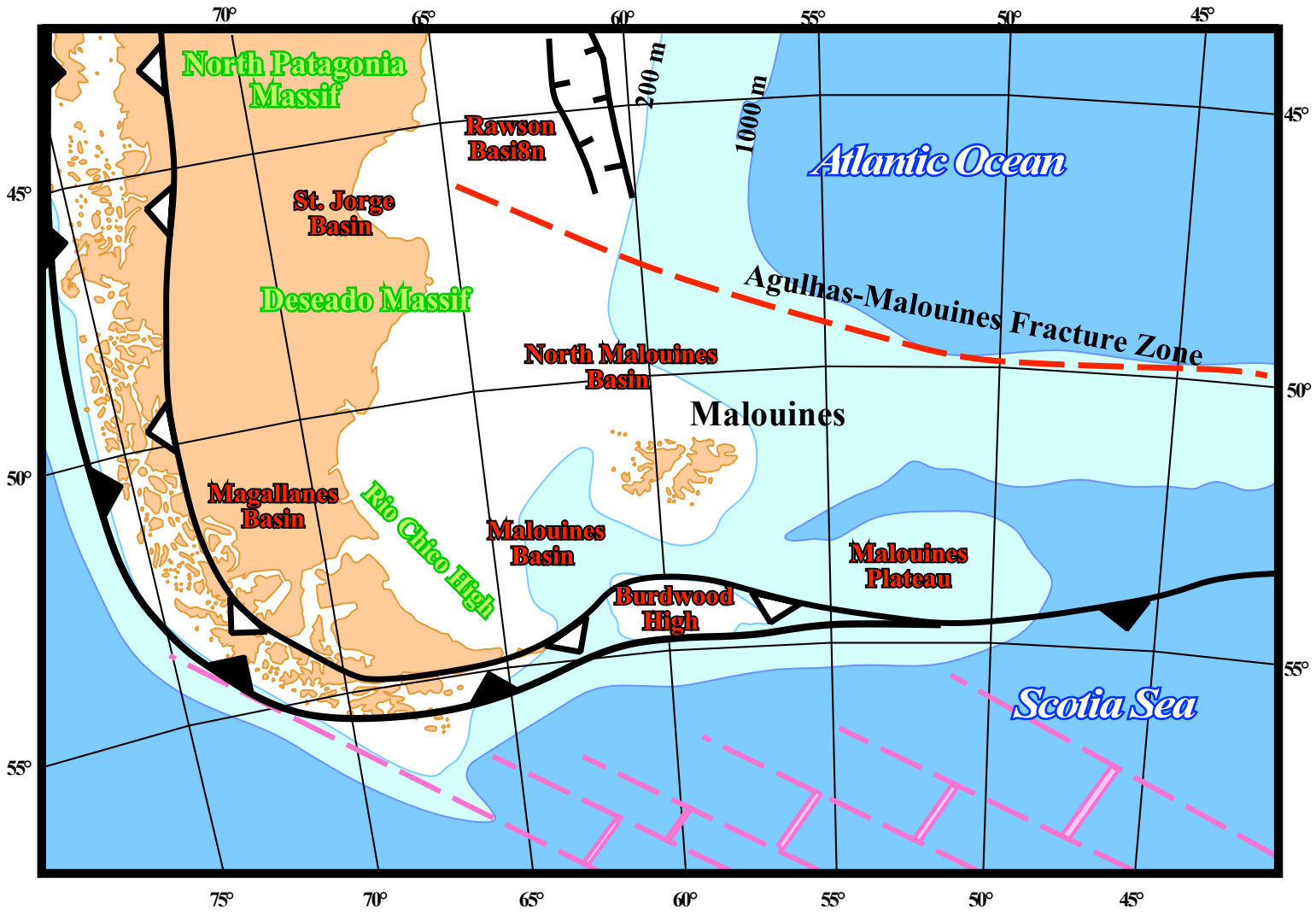
The geological interpretation of this line is speculative. We do not have any calibration. So far no exploration wells have been drilled in the northern Malvinas. The suggested age for crustal breakup is Cretaceous Lower. Two rift-type basins are stacking: one of Late Jurassic age, the other of Lower Cretaceous age.

Ceno-Mesozoic Megasuture



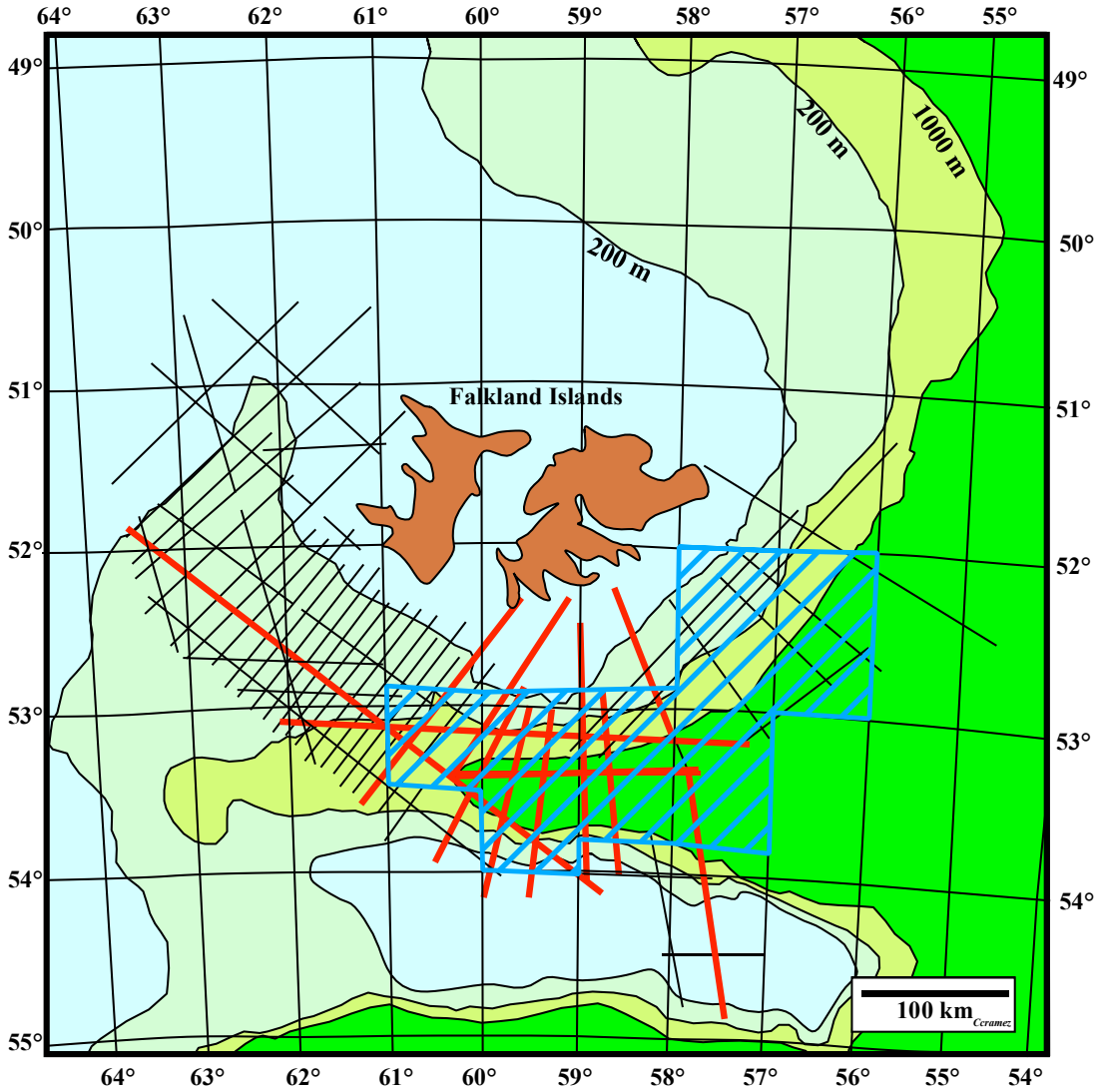
The offshore of the Falklands, in particular its northern part, is directly linked to the subduction of the continental lithospheric plate of South America under the oceanic crust of the Scottish Sea..

Major Geological Features



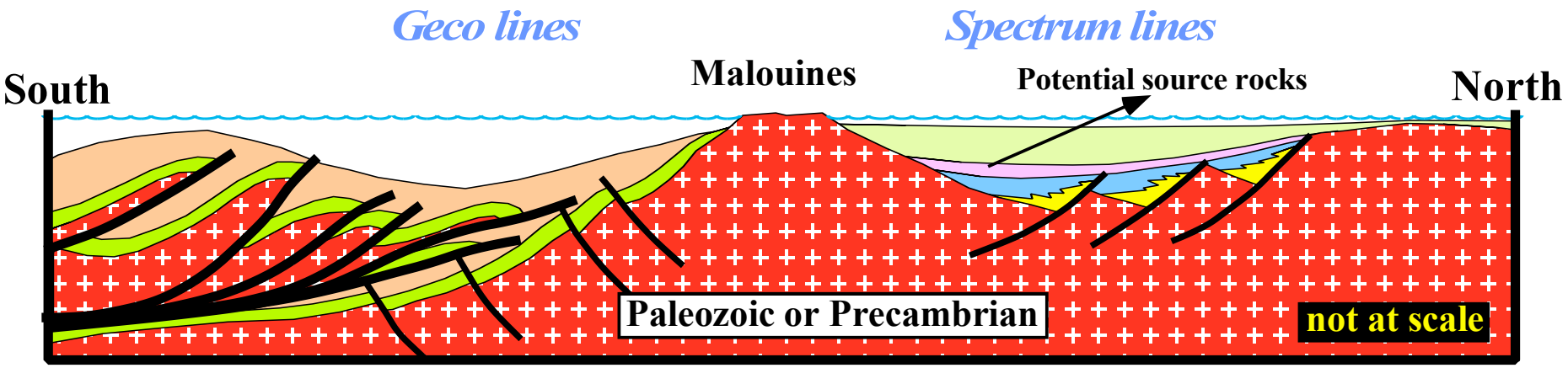
Major geological elements of the northern part of South America and location of speculative seismic campaigns by Spectrum and Geco.

Seismic Grid



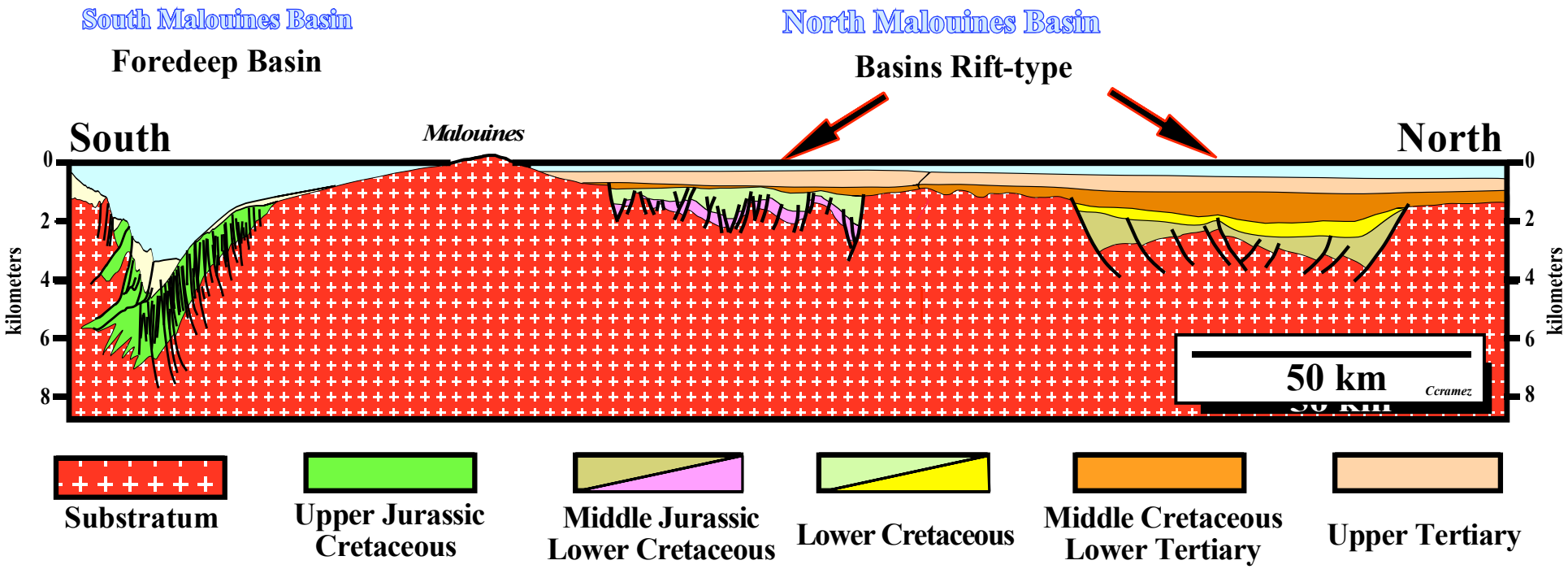
Location of open blocks and speculative seismic campaign by Geco. In red the seismic lines I take a look looked, in Houston at Geco.

Geological Cross-Section

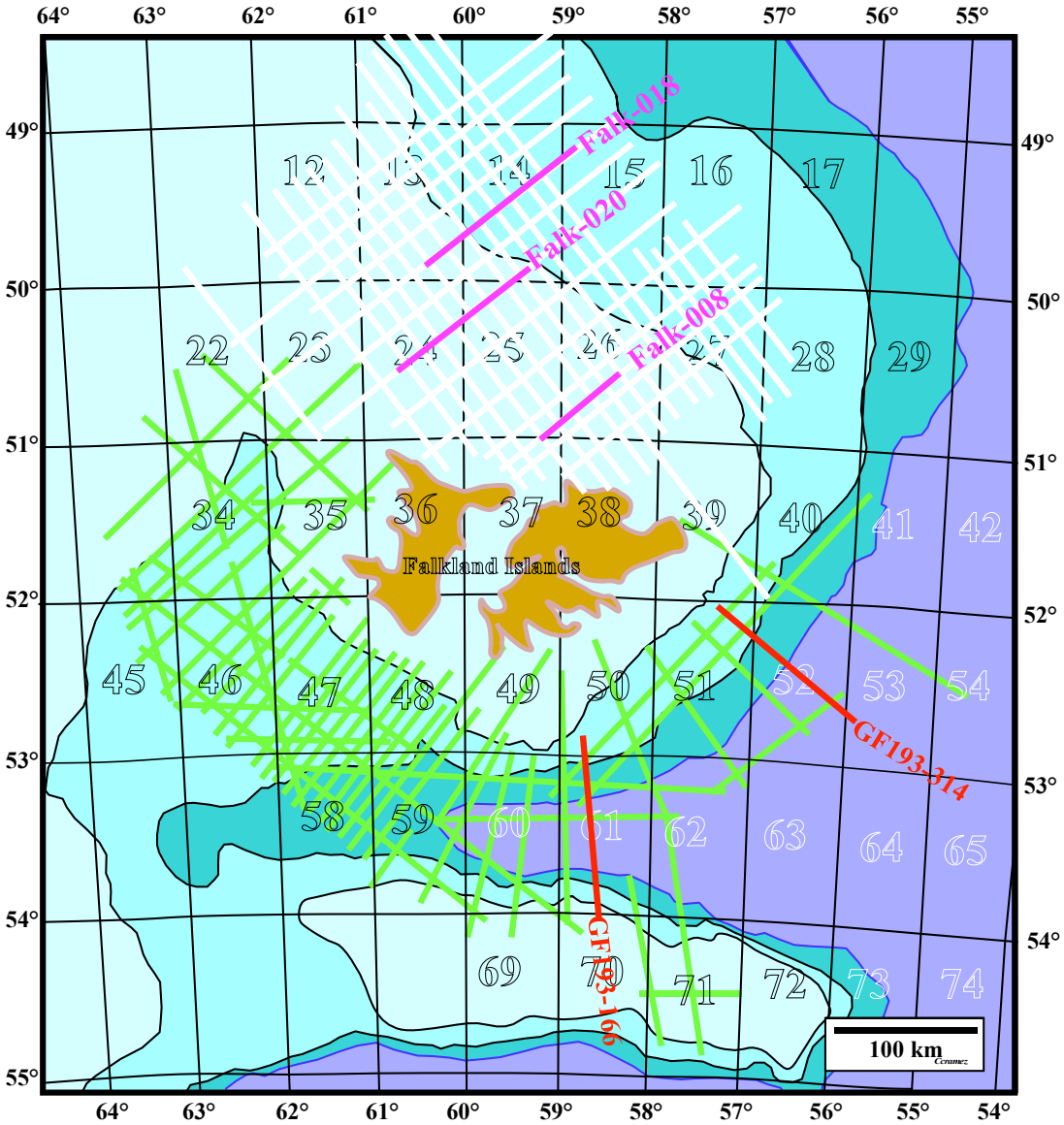


Schematic geological section based on the seismic lines I saw in Houston illustrating, roughly, the geological-petroleum context: (i) significant water depth and no evidence of potential source-rocks, in southern area, (ii) low water depth and possibility of weakly buried lacustrine potential source- rocks in northern area.

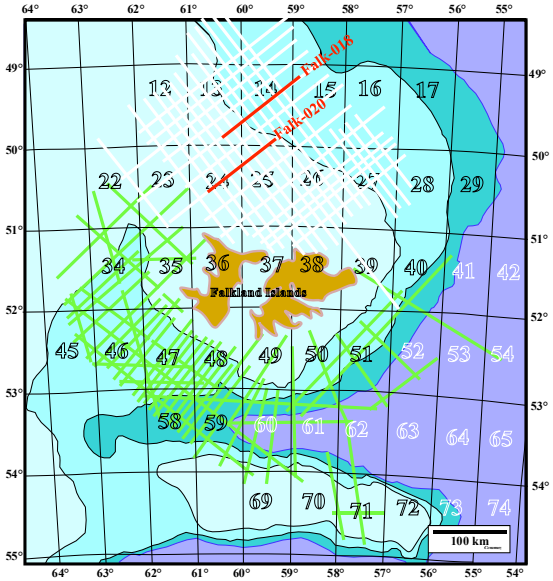
Malouines Basins



Location of the Seismic Lines



The seismic lines of the Geco-Prakla campaign, in the South, East and West Falklands offshores are colored green. Those of the Spectrum campaign, shot, exclusively, in the North of the Falklands, are colored in white. The bathymetric curves are 200, 500 and 1000 meters. The seismic lines in red are those whose geological interpretations are here illustrated.

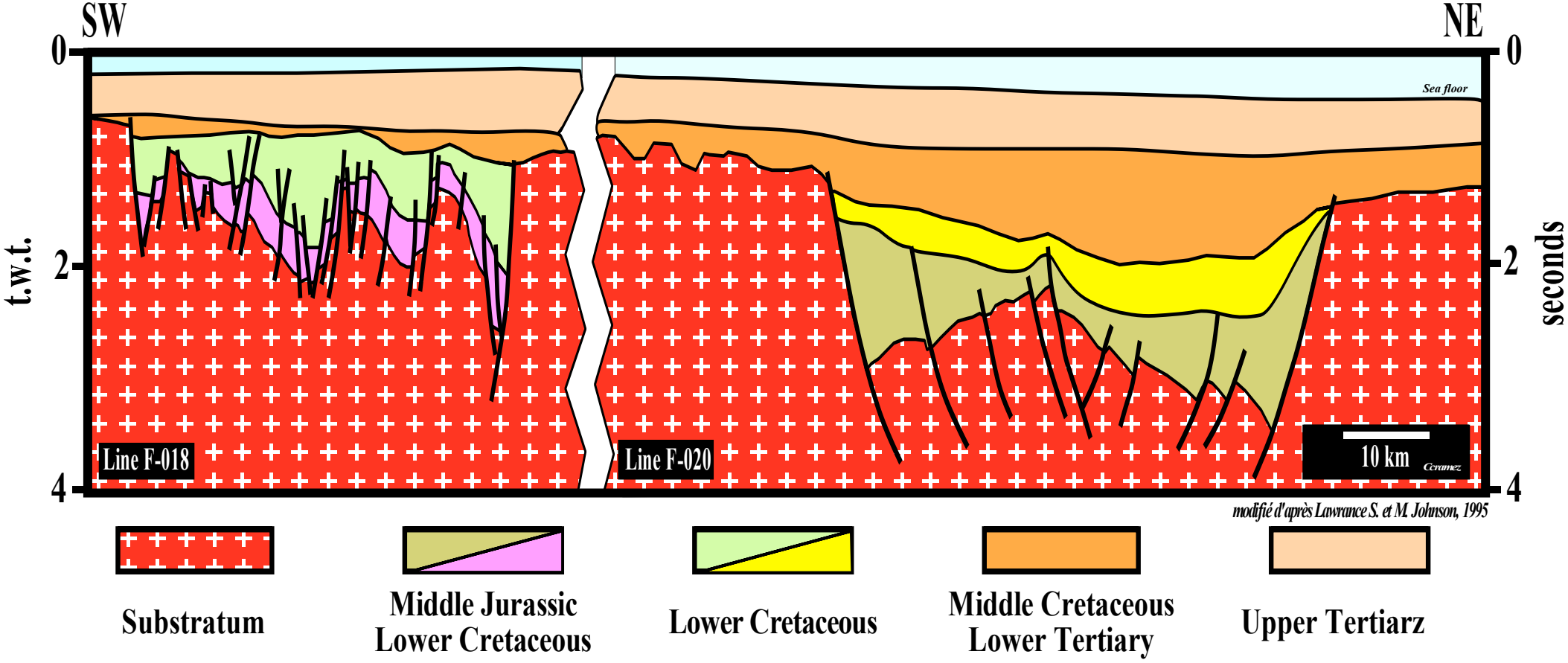


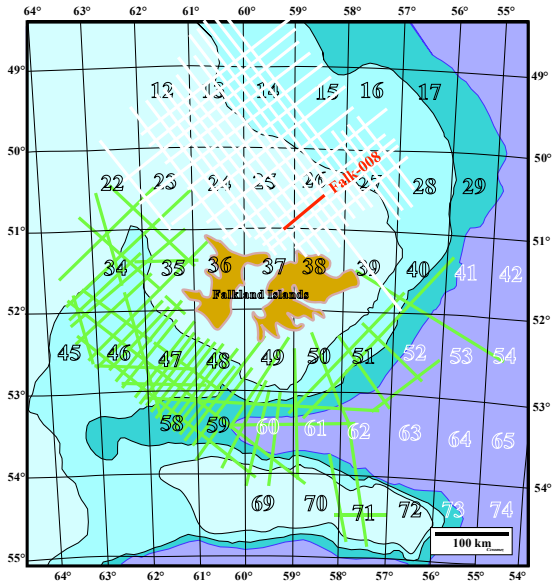
North Offshore Malouines

Tentative Geological Interpretation

Composite Seismic Line

Line F-018 & Line F-020

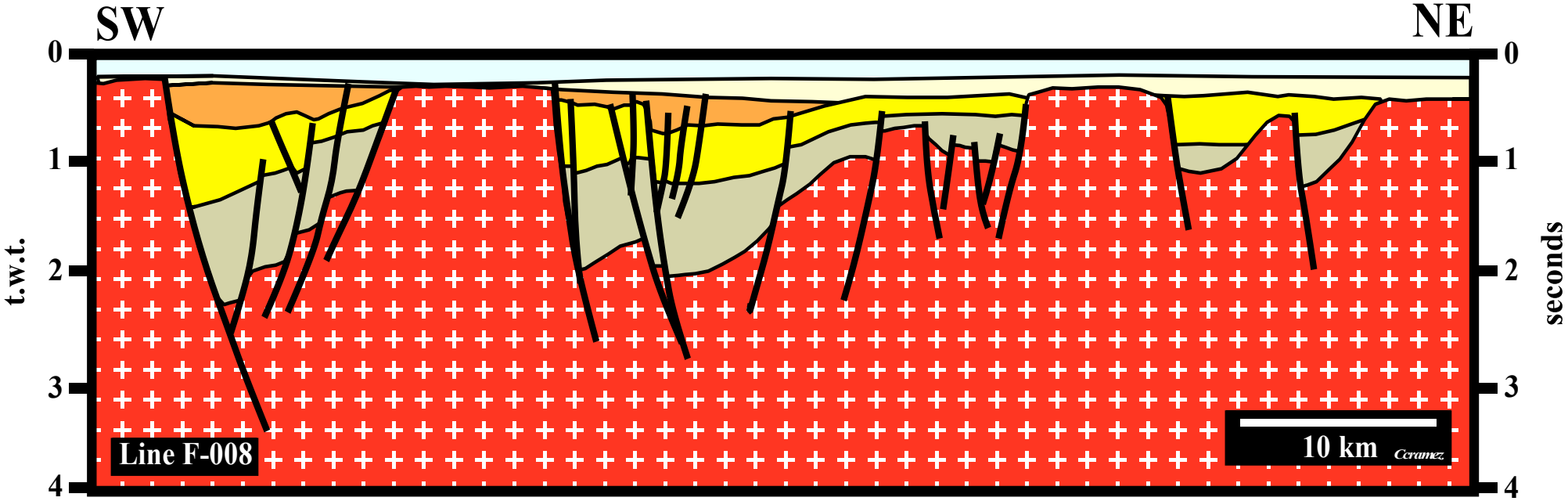




North Offshore Malouines

Tentative Geological Interpretation

Seismic Line F-008



modifié d'après Lawrance S. et M. Johnson, 1995

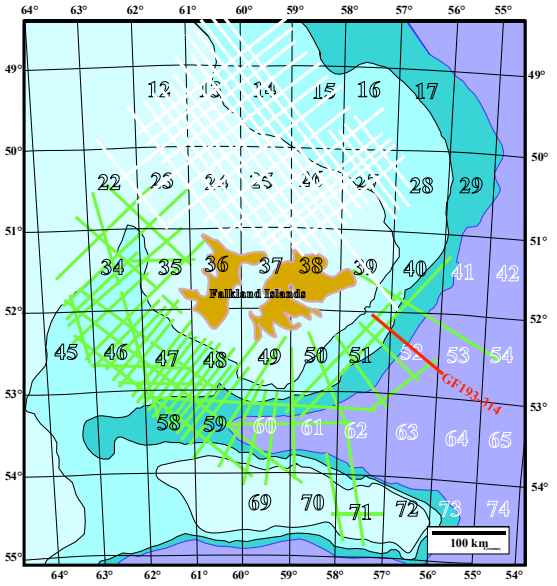
Substratum

Middle Jurassic
Lower Creatceous

Lower Cretaceous

Middle Cretaceous
Lower Tertiary

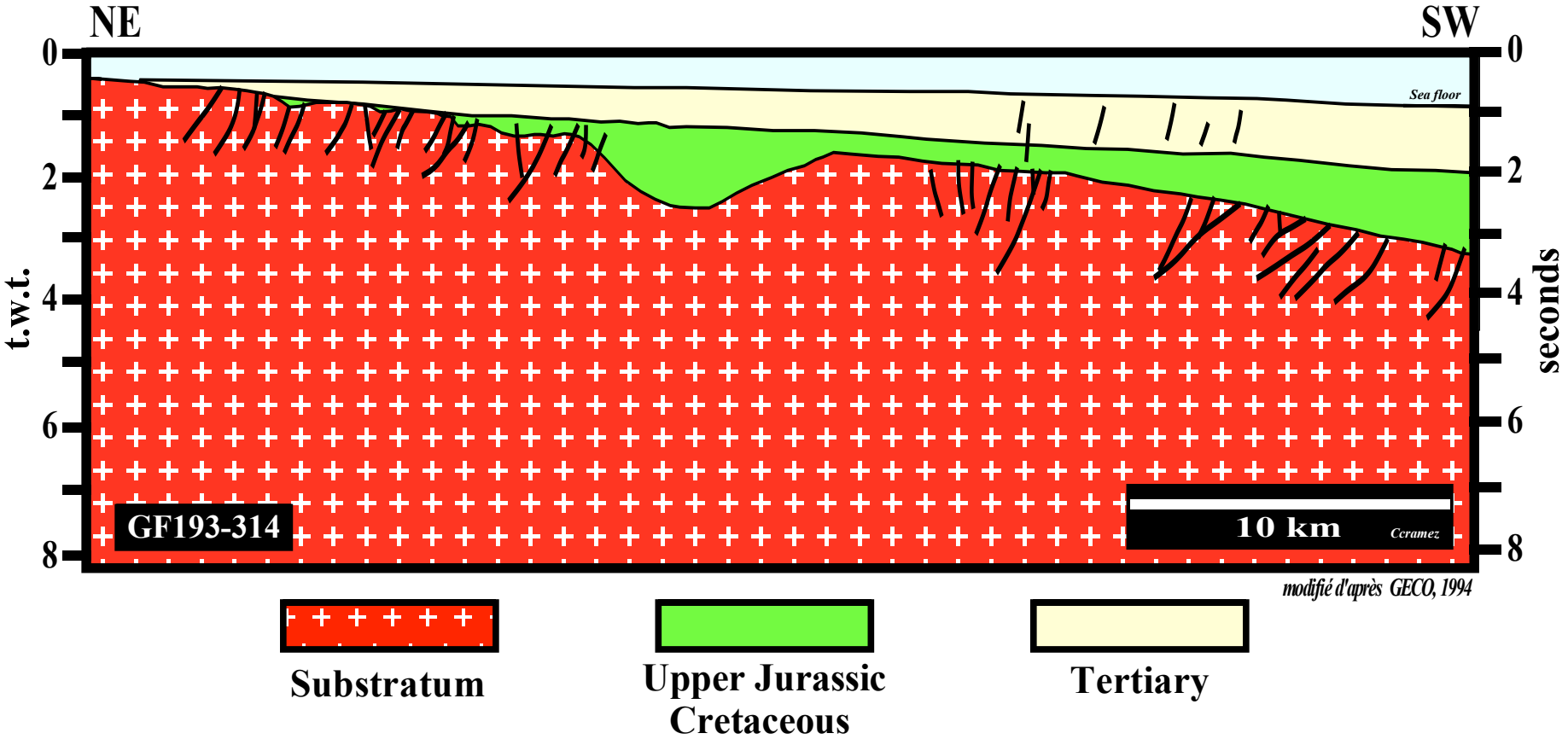
Upper Tertiary

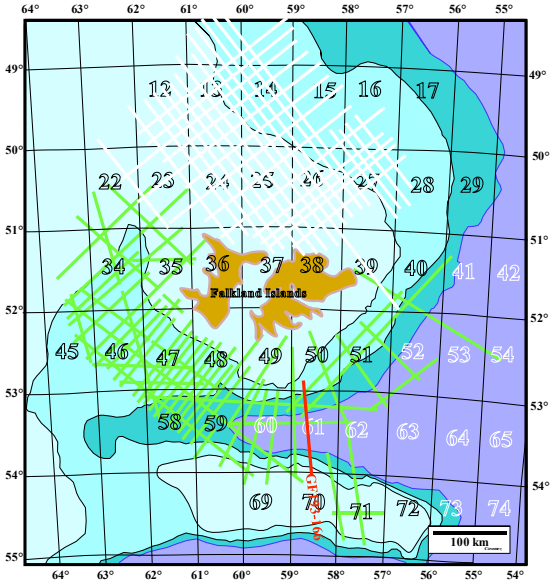


East Offshore Malouines

Tentative Geological Interpretation

Seismic Line GF 193-314

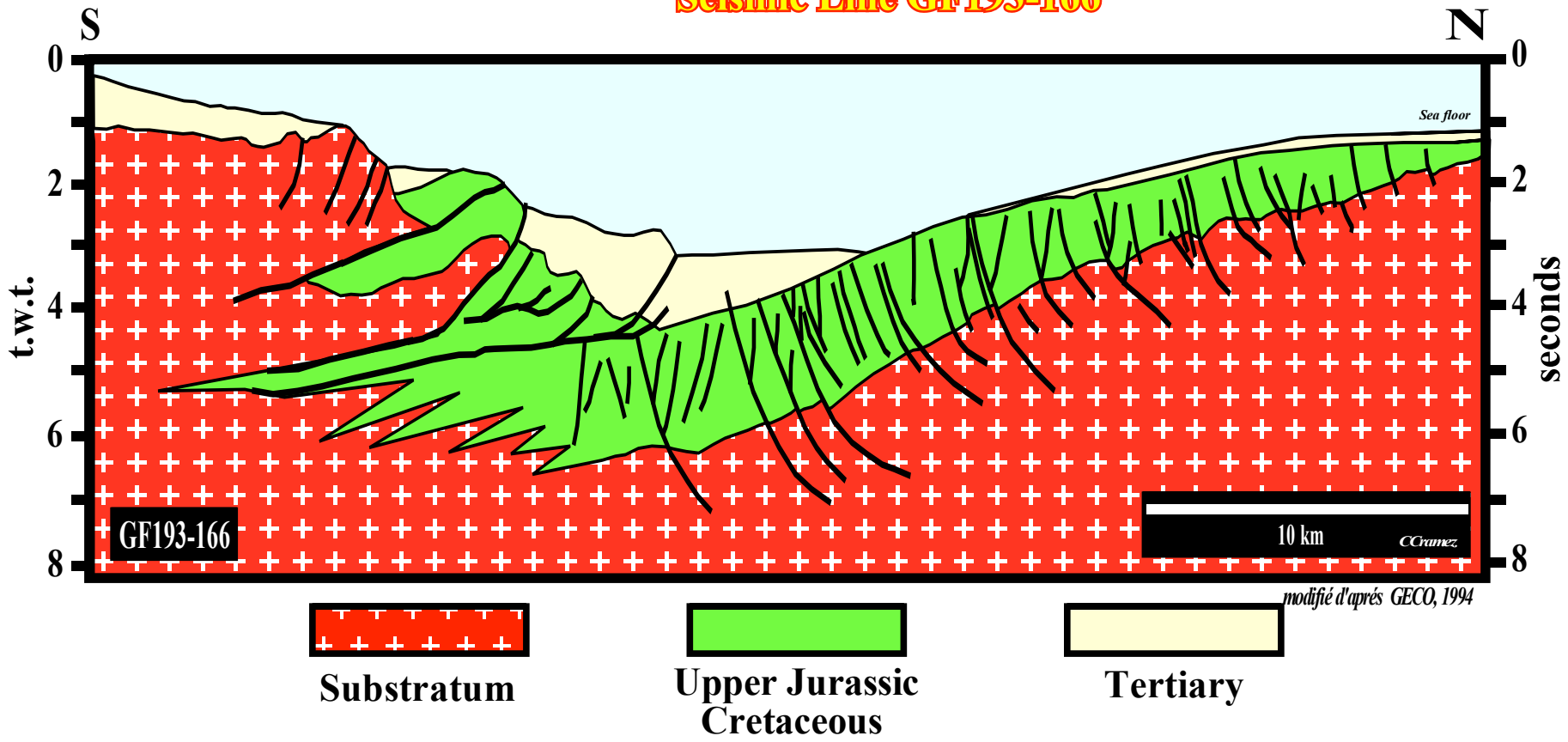




South Offshore Malouines

Tentative Geological Interpretation

Seismic Line GF193-166



Conclusions

The identification and lithological predictions of prograding sedimentary structures require knowledge of a certain number of geological data, namely (i) the tectonic context, (ii) the phisiographic context, (iii) the sedimentary environment, (iv) the geometry, (v) the dimensions, (vi) the distance between the break in slope and the source of terrigeneous supply and (vii) the elevation in other words the gradient, etc. These data allow, most often, the individualization on the seismic data of different progradational sedimentary structures, i.e. (a) Alluvial fans, (b) Continental slopes, (b) Common deltas, (c) Deltas associated with fans alluvial, (Gilbert deltas) , (d) deltas associated with braided rivers, (e) lava deltas, (f) submarine slope fans, (g) SDRs etc., as well to as advance lithological predictions.

In the following note, the main purpose of which is to approach the lithology of the progradational intervals of the northern basin of the Malvinas, I will, first, make a rapid recapitulation of the characteristics of the various most frequent progradational geological body, namely:

(i) Alluvial fans,

(ii) Continental slopes,

(iii) Common deltas,

(iv) Deltas associated with alluvial fans,

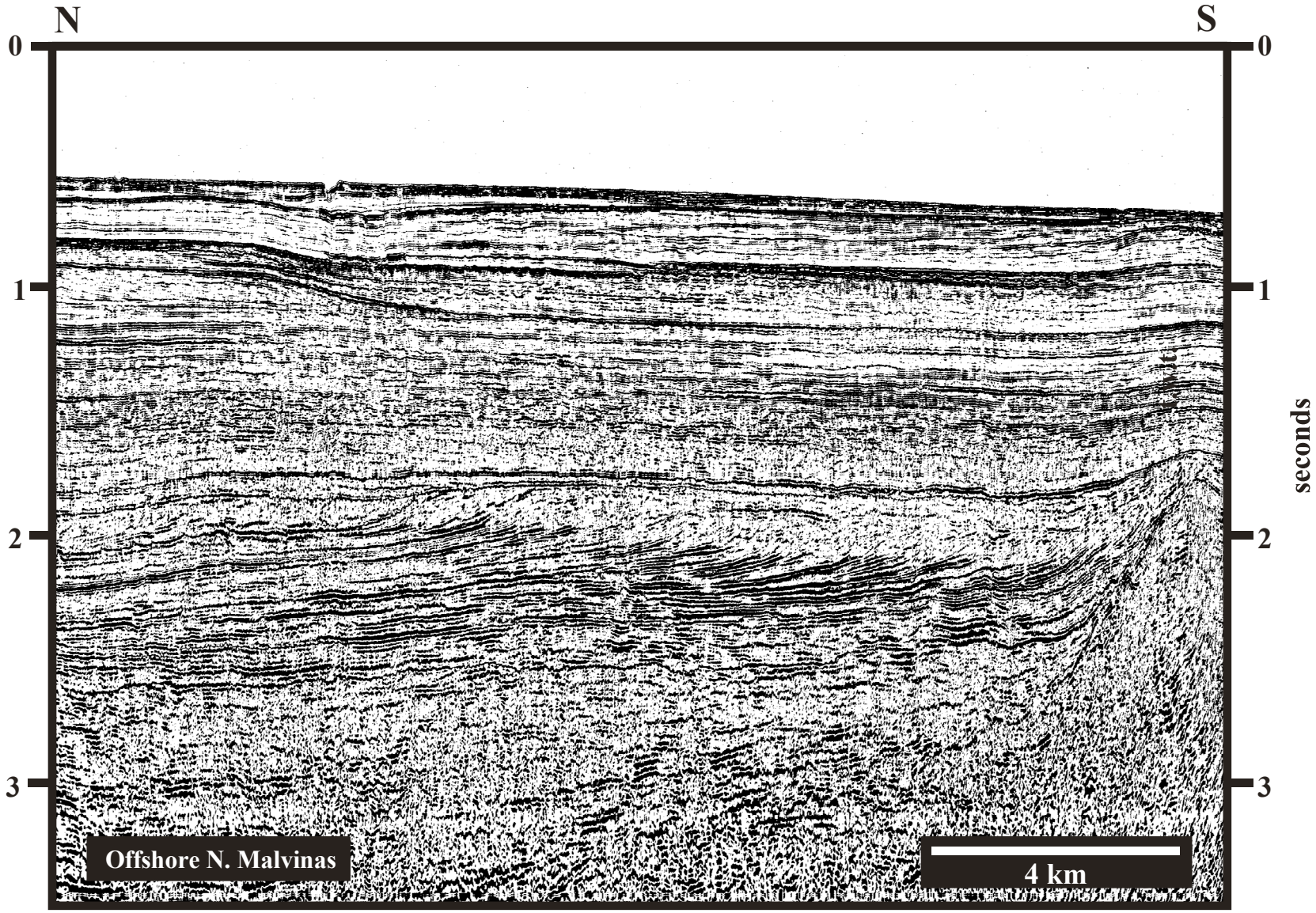
(v) Deltas associated with braided rivers,

(vi) Lava deltas,

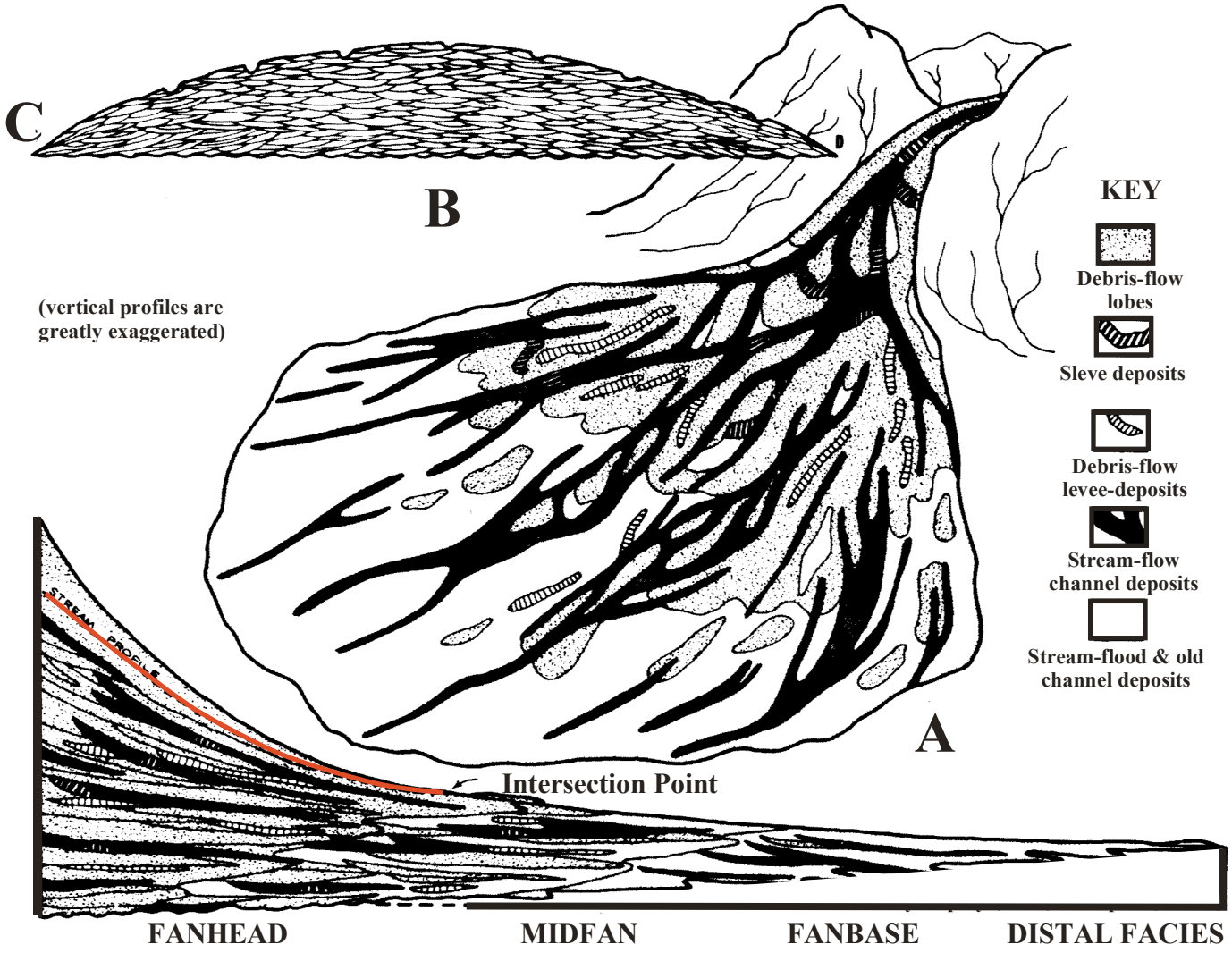
(vii) Submarines fans,

(ix) SDRs, etc.

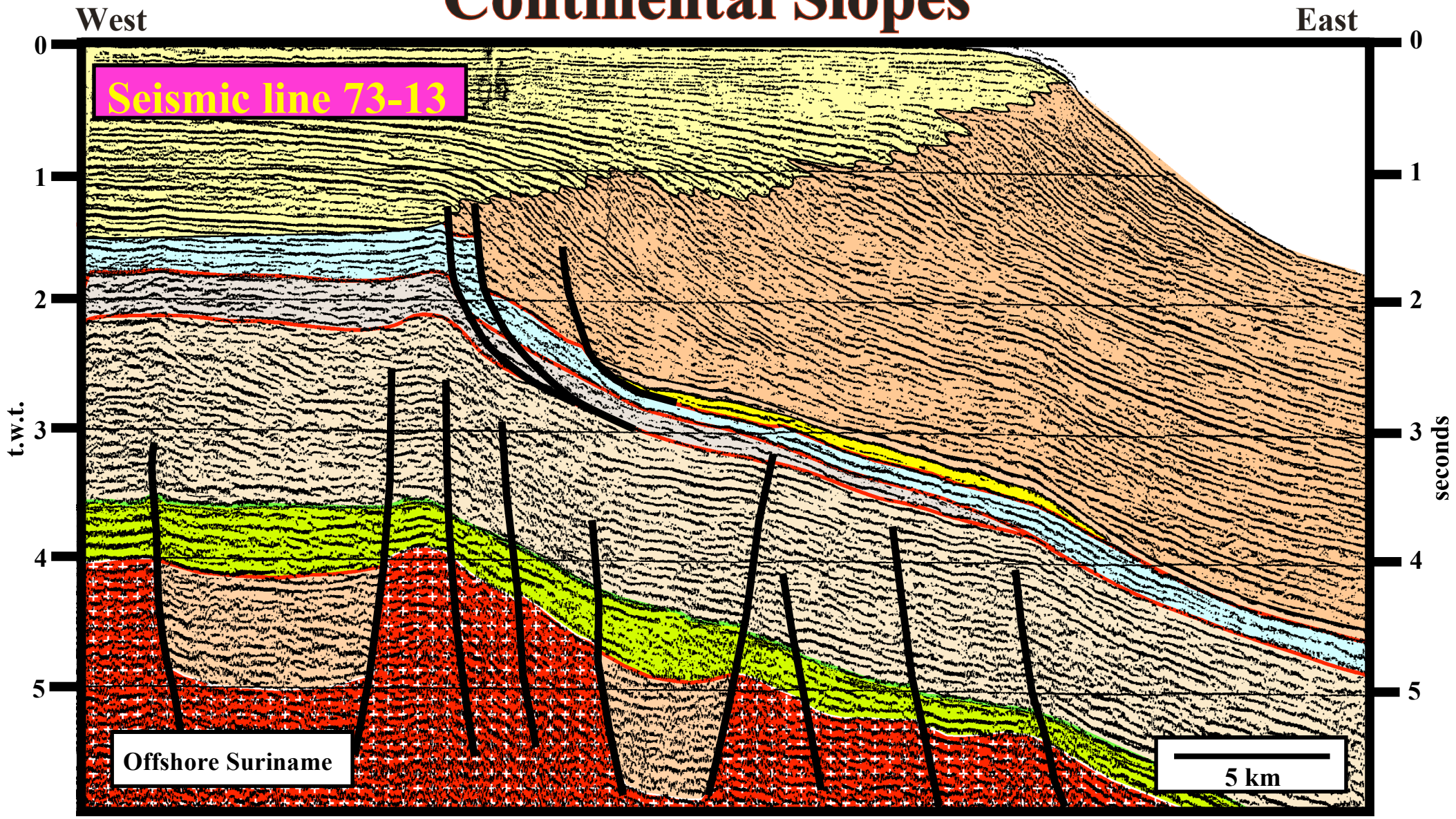
Seismic line MK-87-147



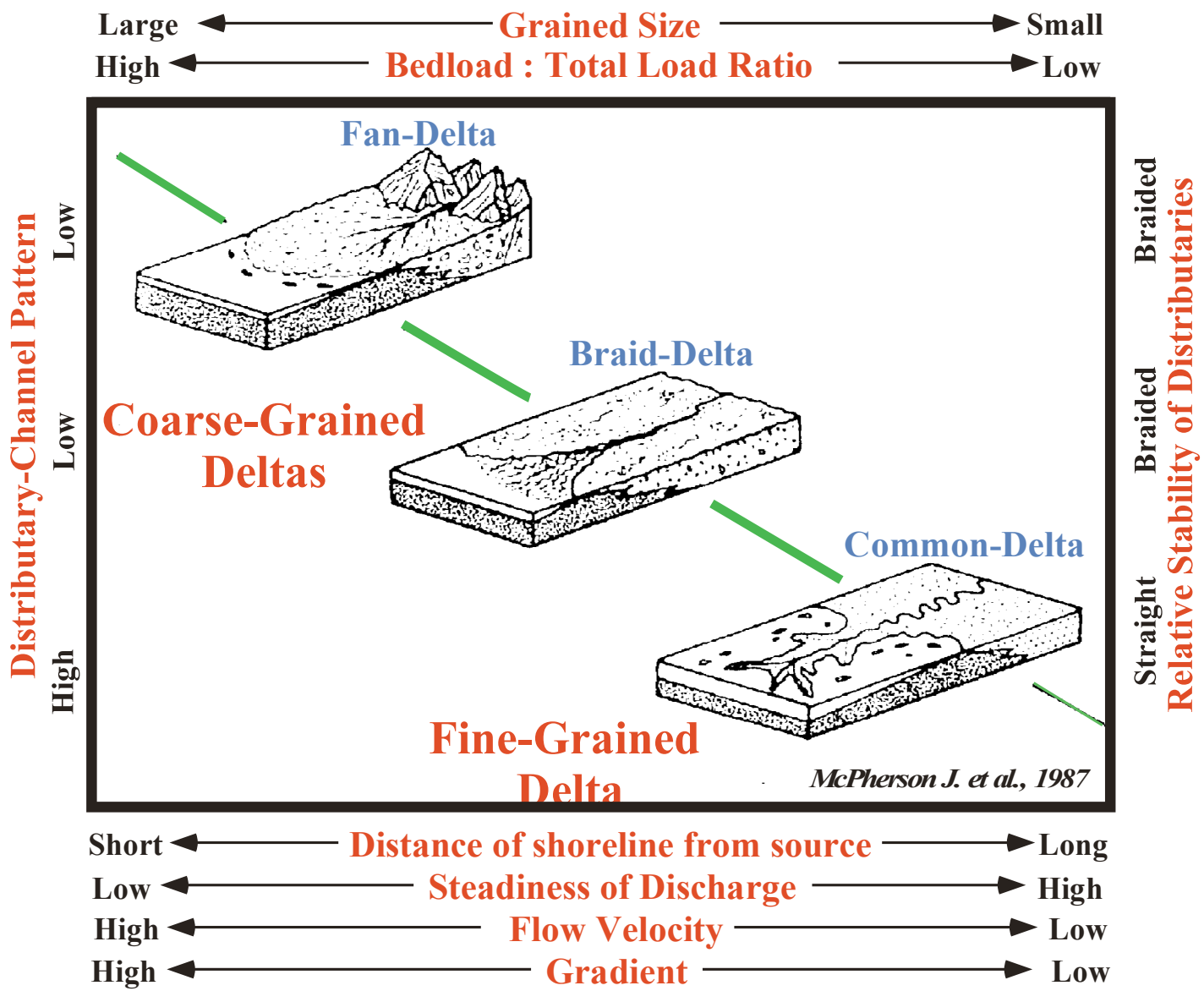
Alluvial-Fans



Continental Slopes

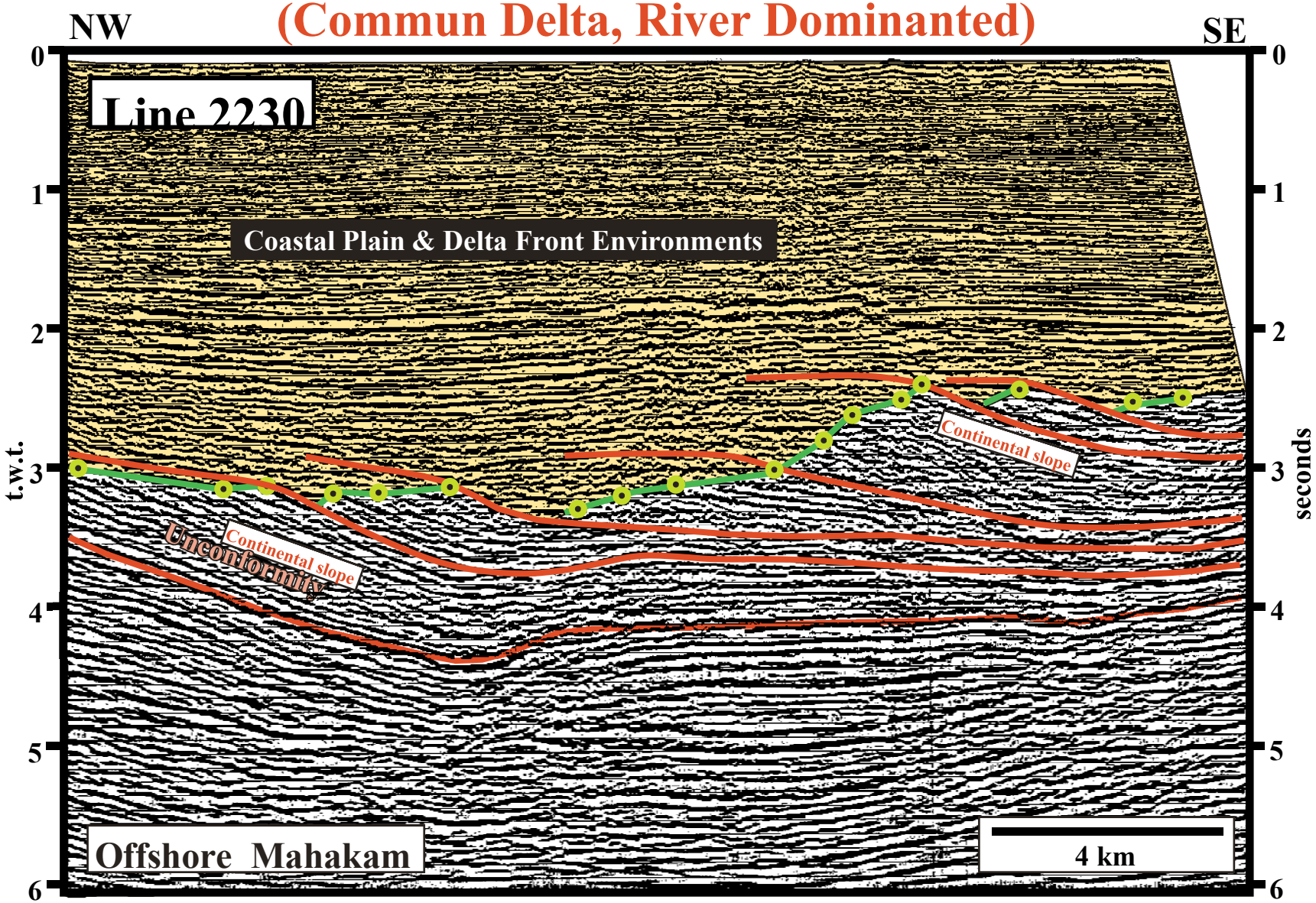


Deltas s. l.

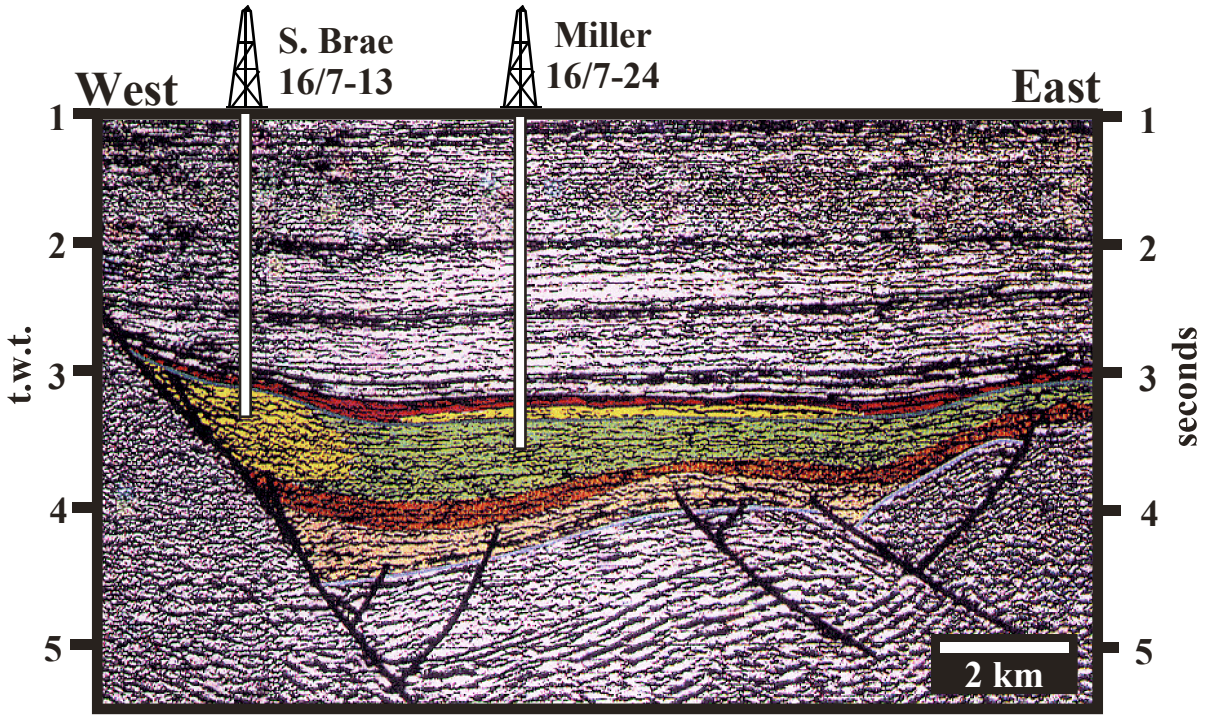

Large
Grained Size
Small
High
Bedload : Total Load Ratio
Low
Distributary-Channel Pattern
Low
Low
High
Relative Stability of Distributaries
Braided
Braided
Straight
Fan-Delta
Braid-Delta
Common-Delta
Coarse-Grained Deltas
Fine-Grained Delta
McPherson J. et al., 1987
Short
Distance of shoreline from source
Long
Low
Steadiness of Discharge
High
High
Flow Velocity
Low
High
Gradient
Low

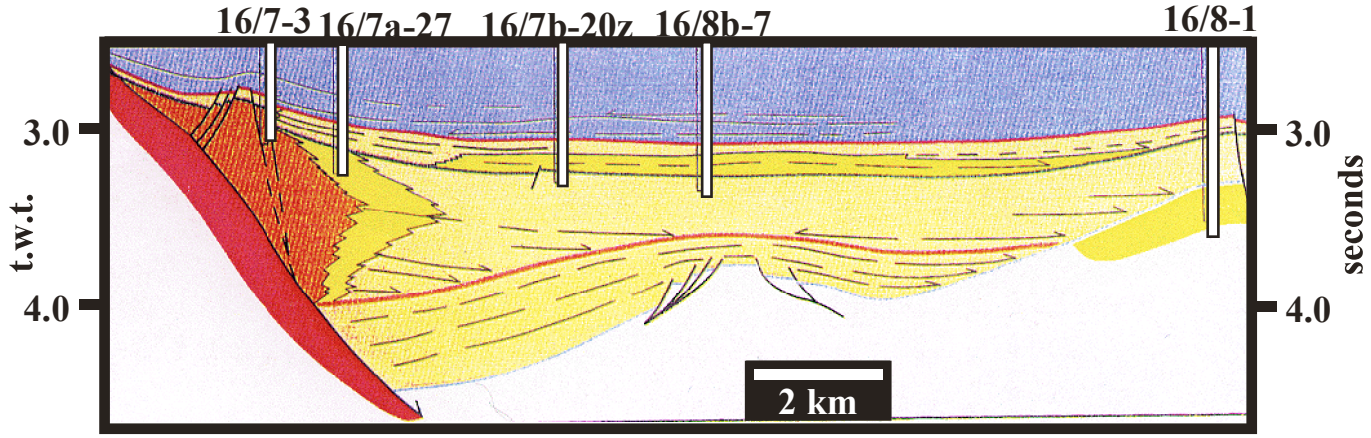
Mahakam Delta

(Commun Delta, River Dominanted)

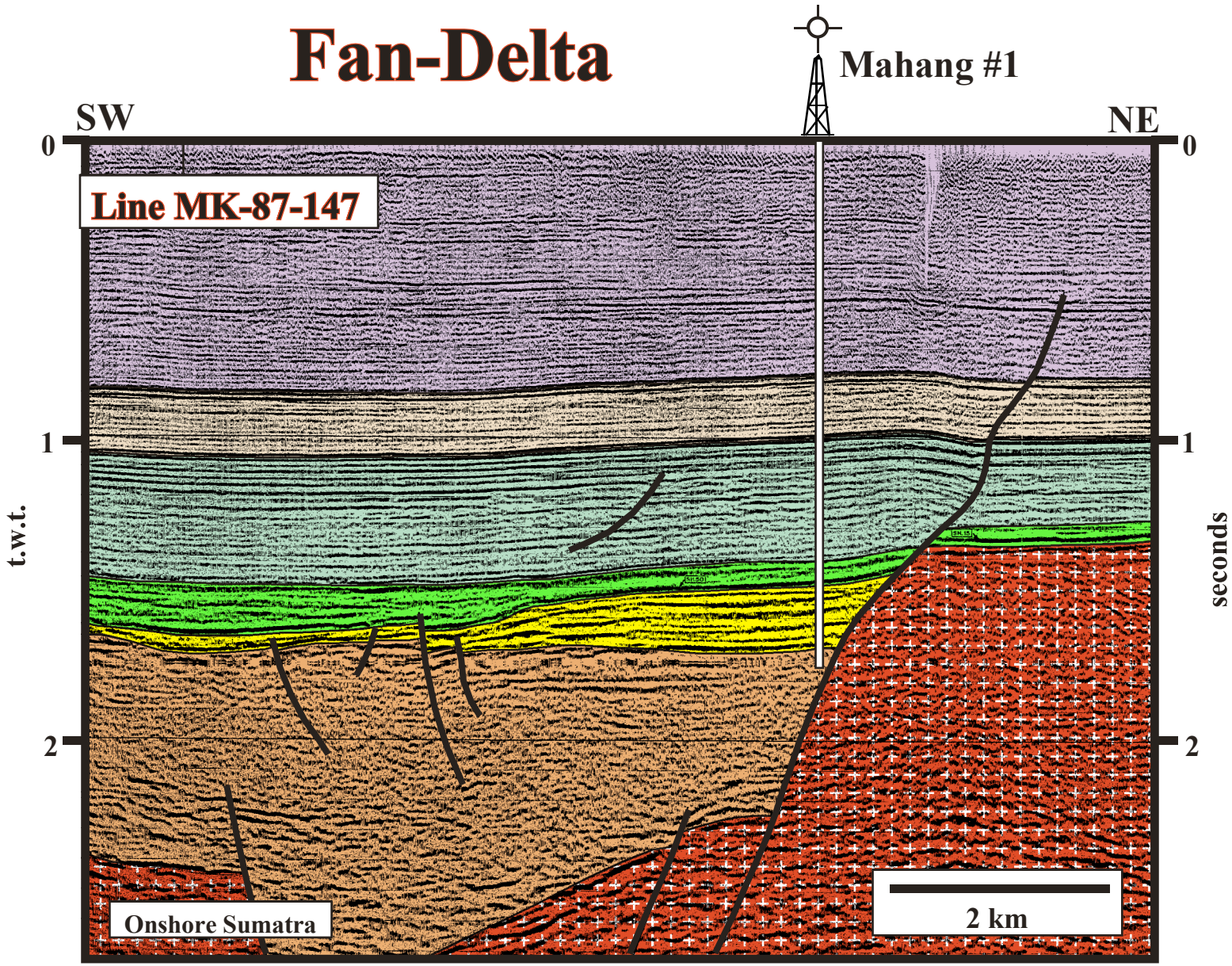


Courtesy of TI

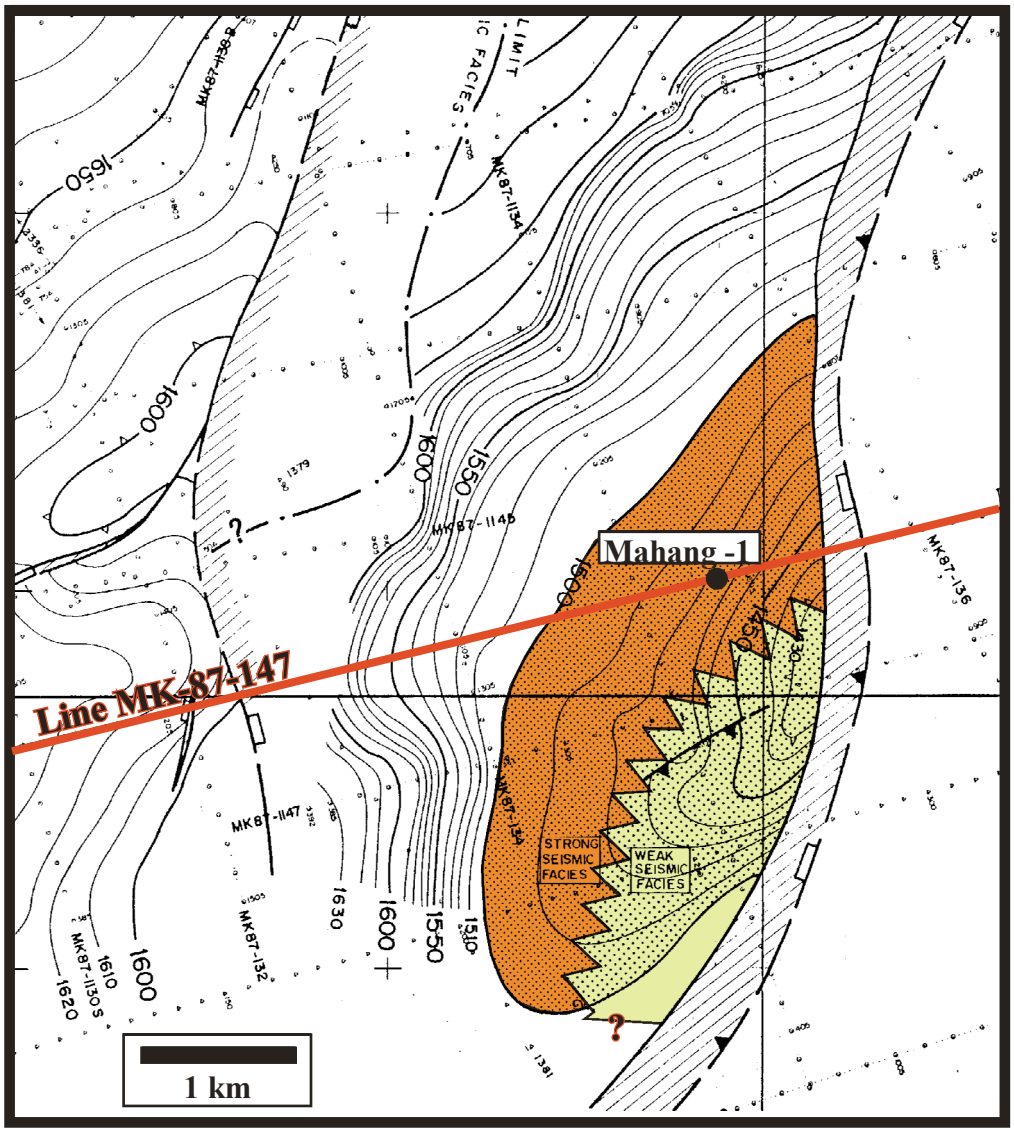

West
S. Brae
16/7-13
Miller
16/7-24
East
t.w.t.
seconds
1
2
3
4
5
2 km


16/7-3
16/7a-27
16/7b-20z
16/8b-7
16/8-1
t.w.t.
seconds
3.0
4.0
2 km

Fan-Delta



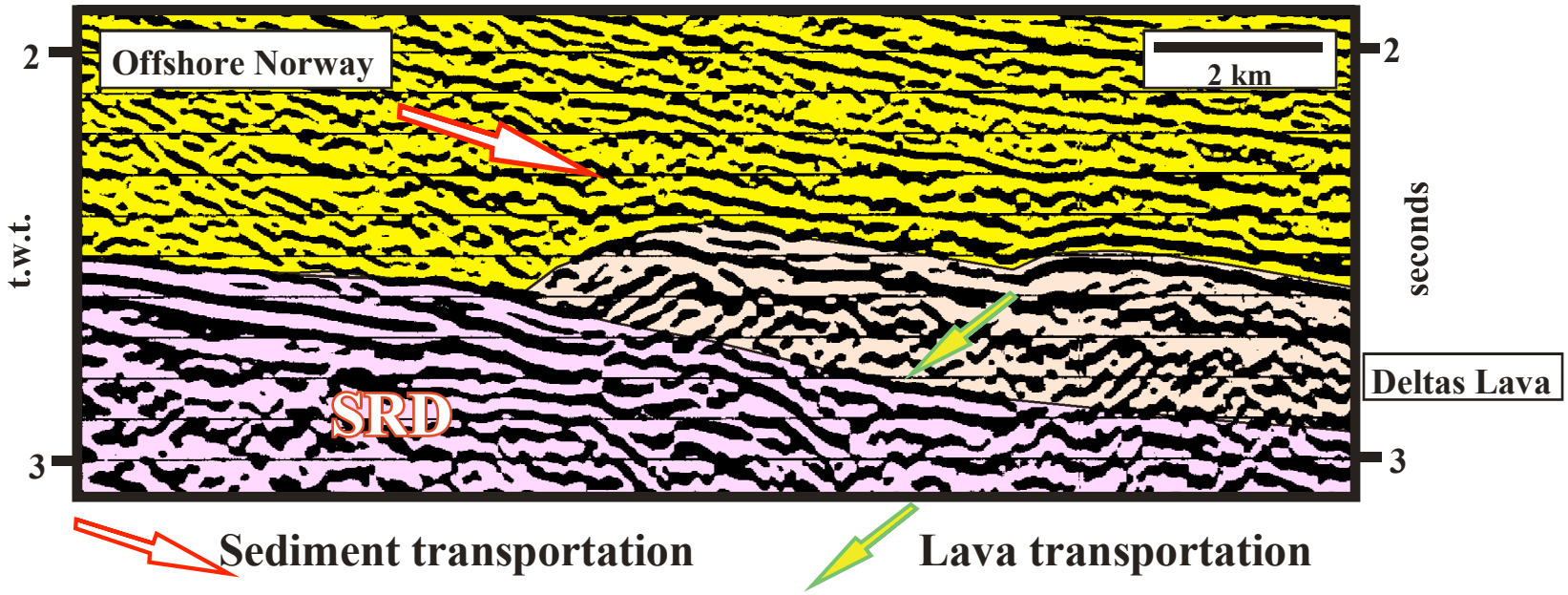
Total Indonésie Interpretation



Fan-Delta
Time Structure Map

From Drilling Proposal TI (1988)

Seaward Dipping Reflectors & Deltas Lava



Seaward Dipping Reflectors (SDRs)