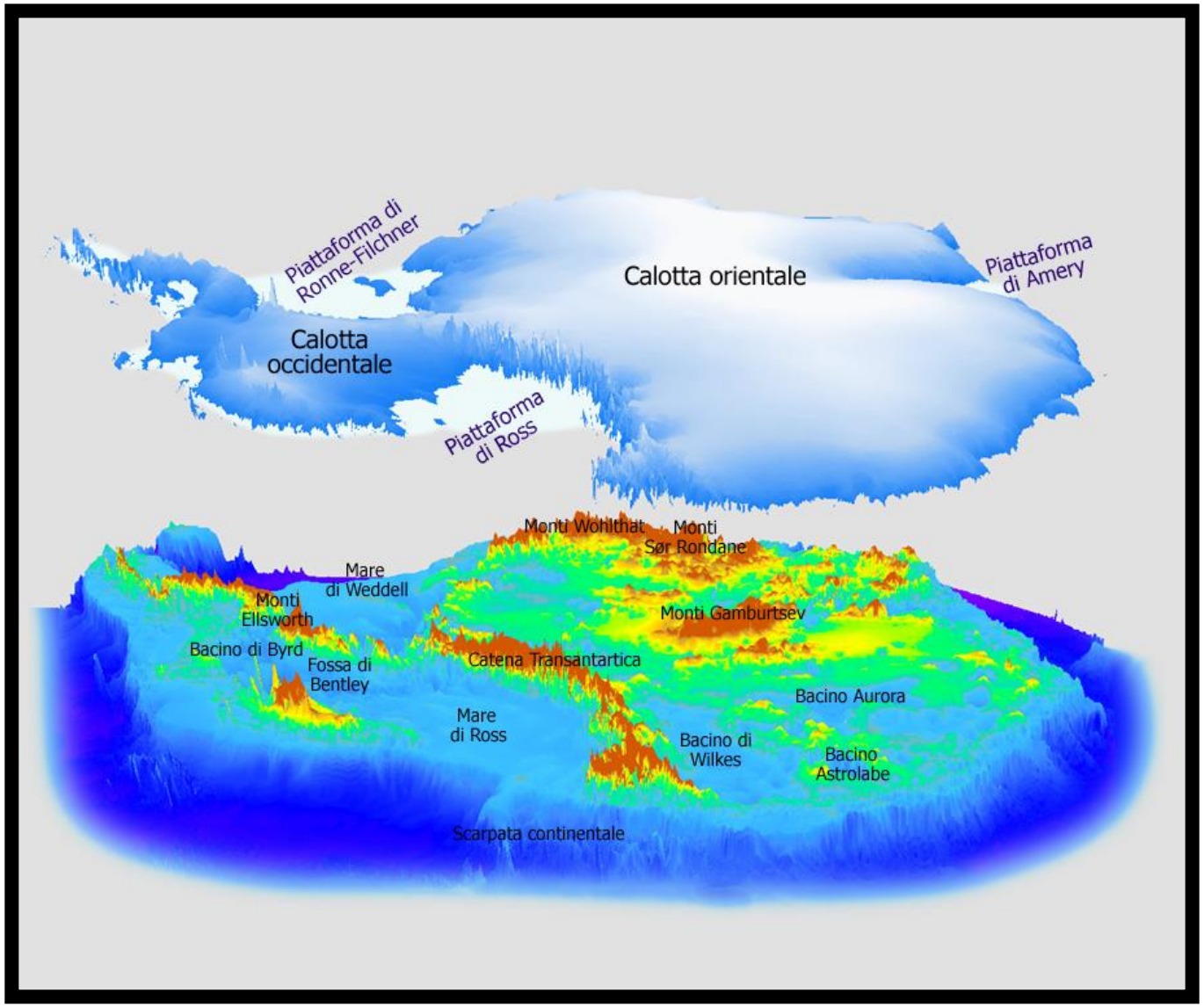
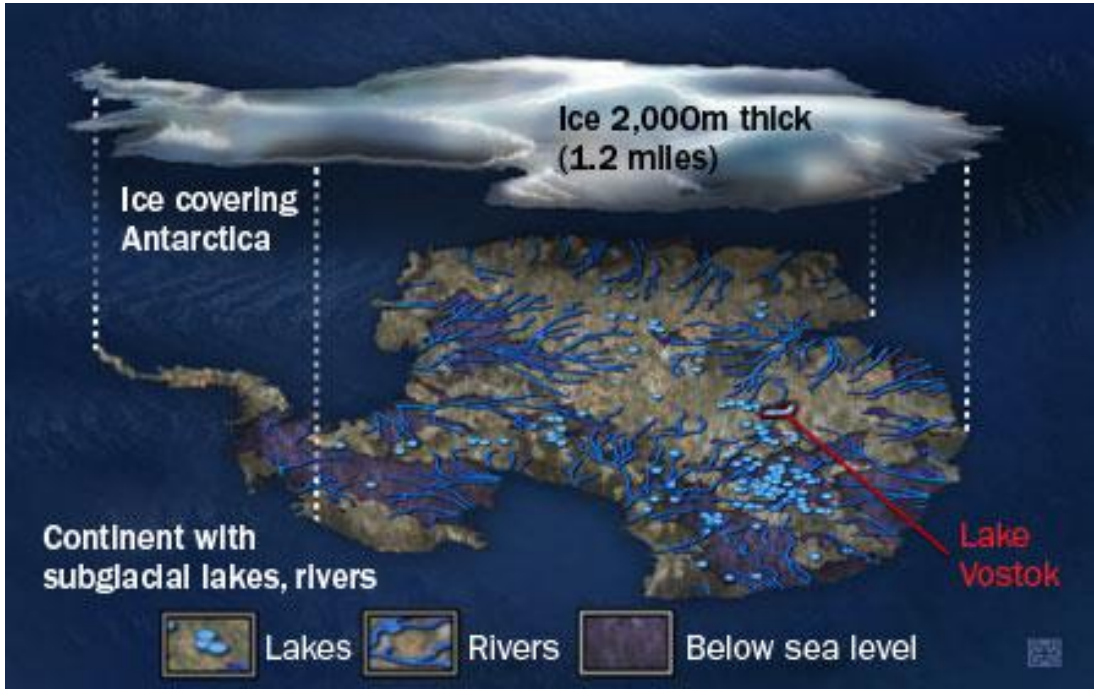
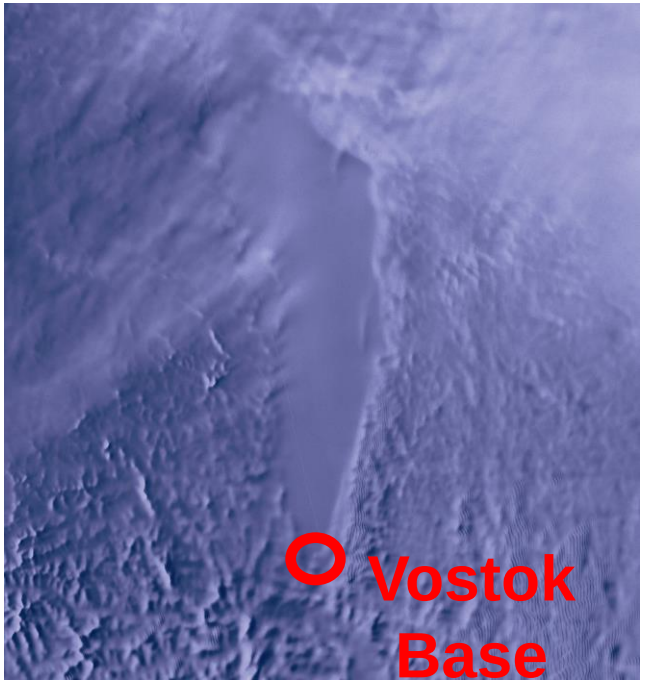
Subglacial topography




Northern Victoria Land
Figure is from Baroni
Western Italian Alps

RETE DI LAGHI SUBGLACIALI SOTTO LA CALOTTA





Vi e' l'evidenza scientifica di una fitta rete di laghi subglaciali sotto la calotta ghiacciata. Perche' si vogliono studiare:

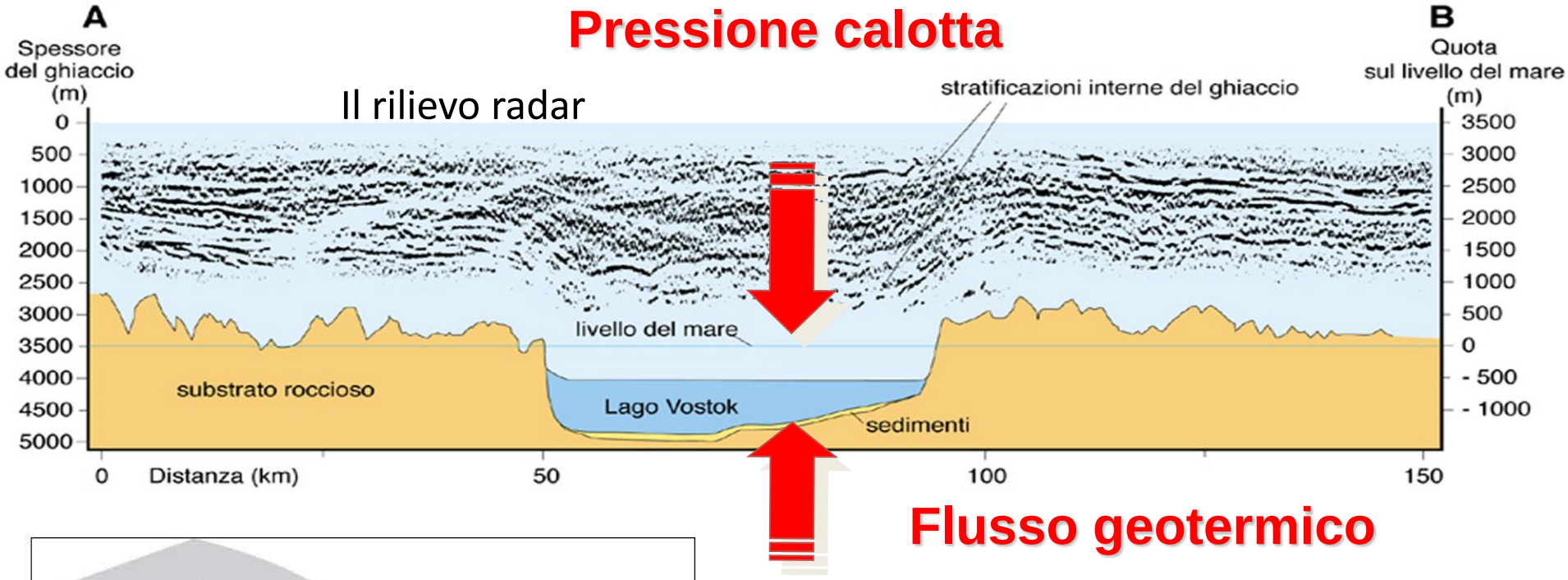
1- un'eventuale destabilizzazione della calotta comincierebbe proprio dalla sua base,

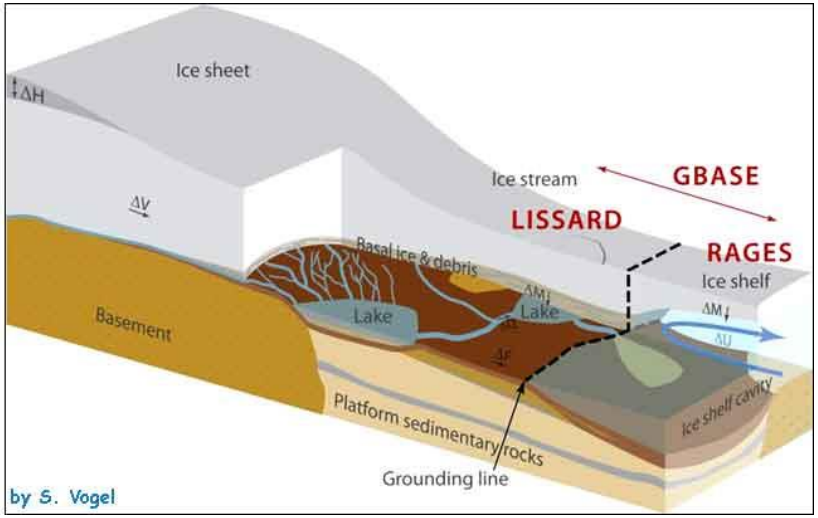
2- contengono la storia dell'Antartide antecedente a 800.000 anni fa,

3- contengono organismi isolati dal resto del mondo da molto tempo,

4- rappresentano l'habitat che si ha su alcuni satelliti di Giove.

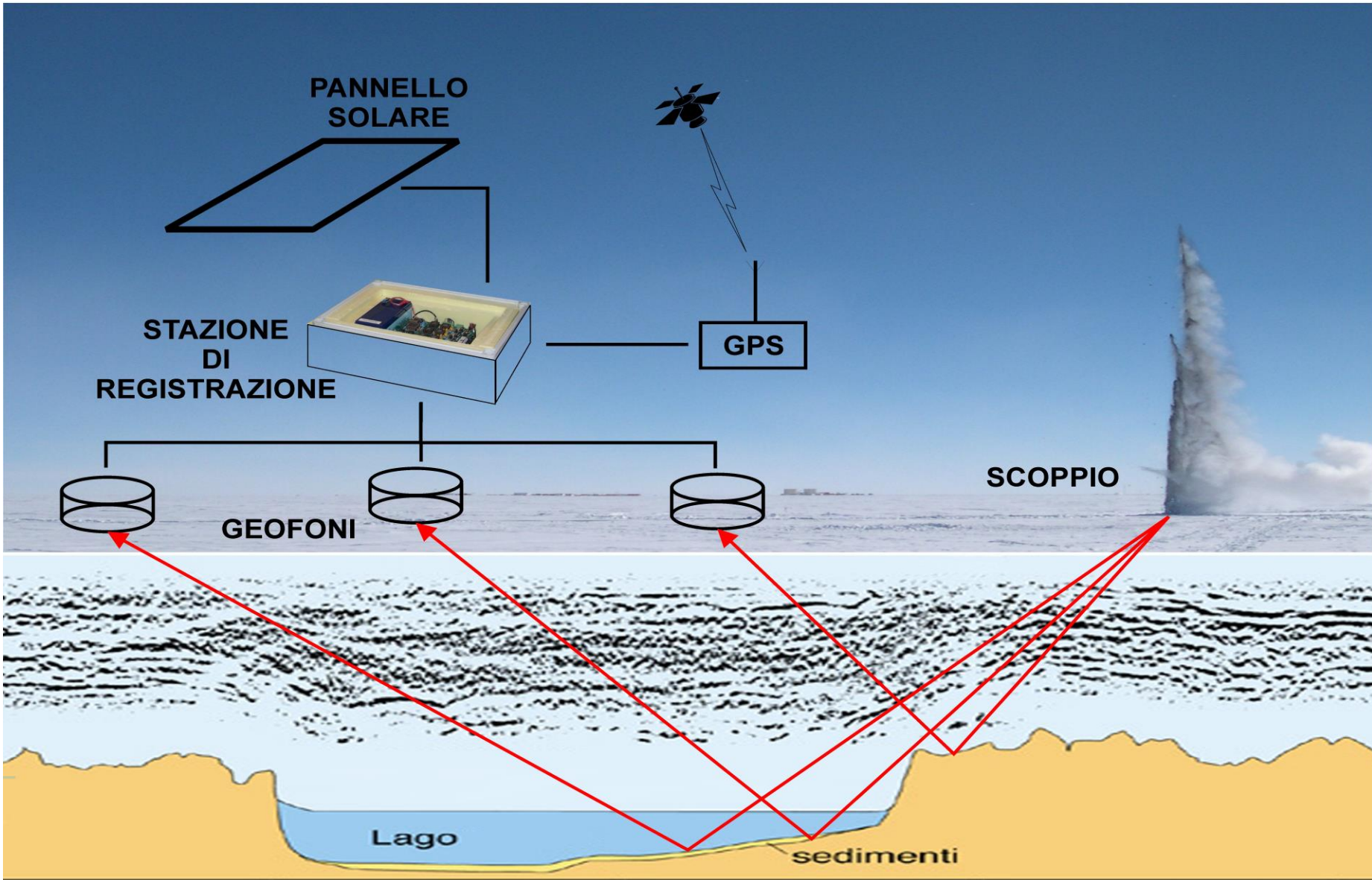
Che cosa sono i laghi subglaciali?



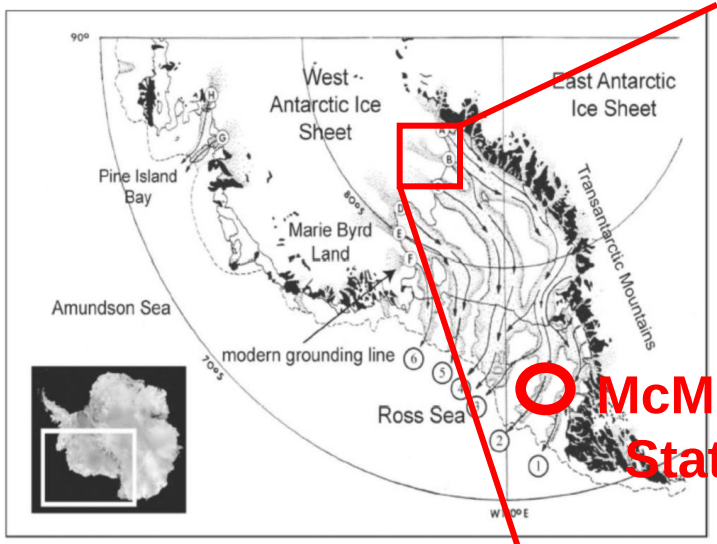


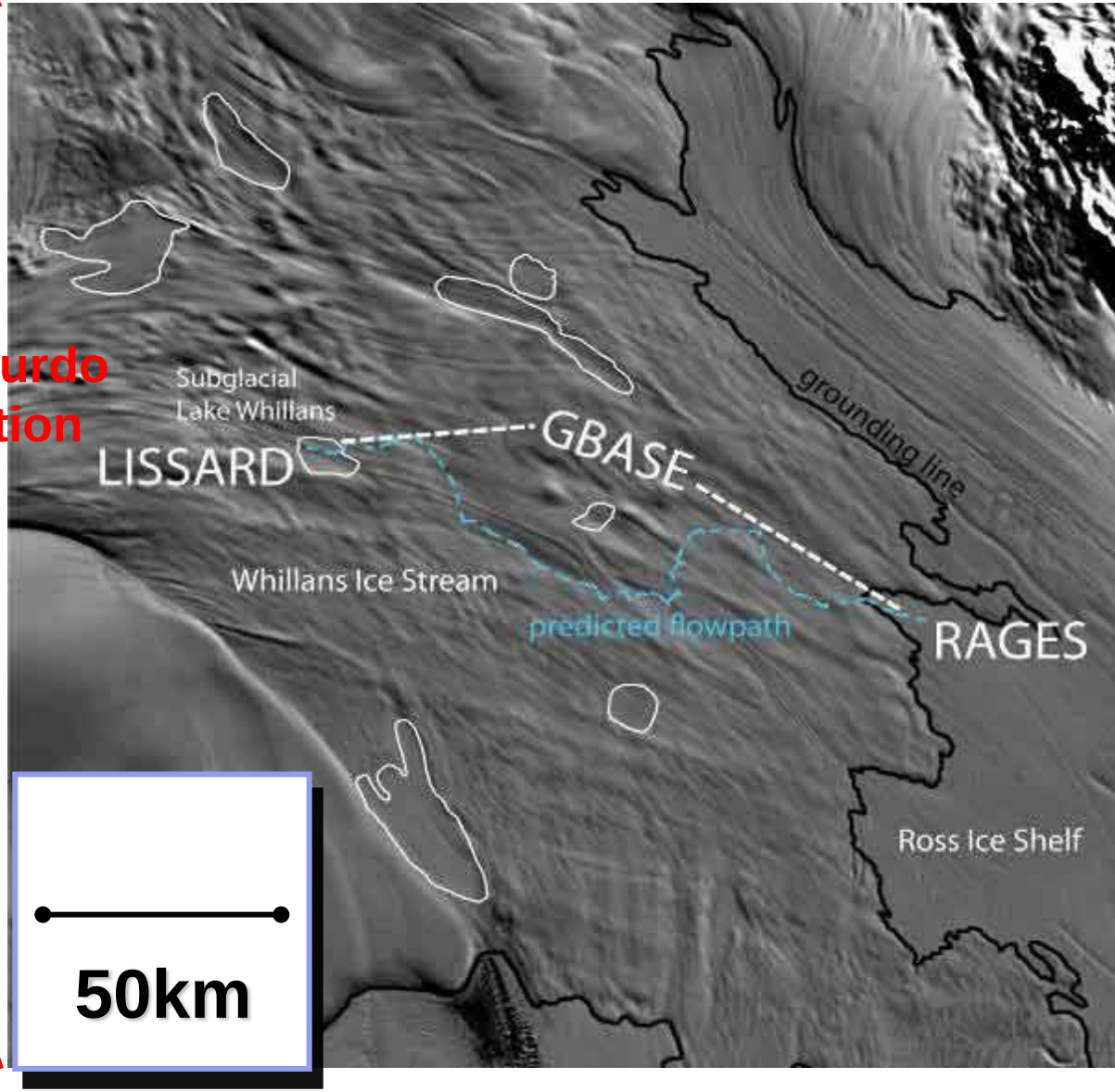
I laghi subglaciali possono essere comunicanti con il mare, oppure completamente isolati rispetto al resto del mondo

La sismica a riflessione permette di conoscere il tipo del substrato roccioso e sedimentario sotto la calotta glaciale



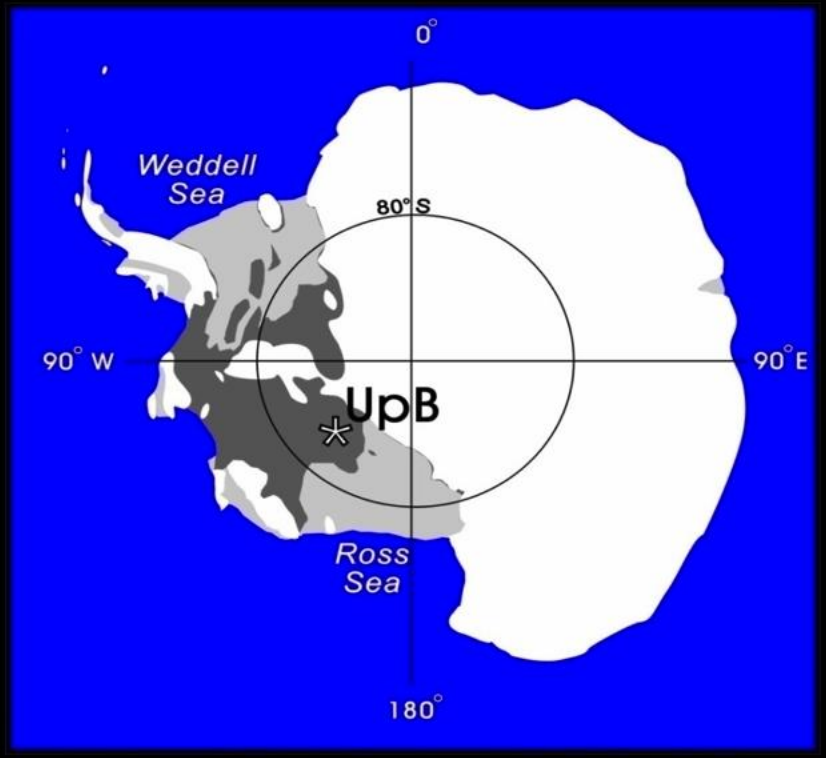
GHIACCIAIO WHILLANS DA SATELLITE





Il ghiacciaio Whillans è largo 150km, lungo 500km e si sposta ad una velocità di 3m al mese!!!

Sediments recovered from beneath the ice provided the only direct evidence of marine events in the West Antarctic interior

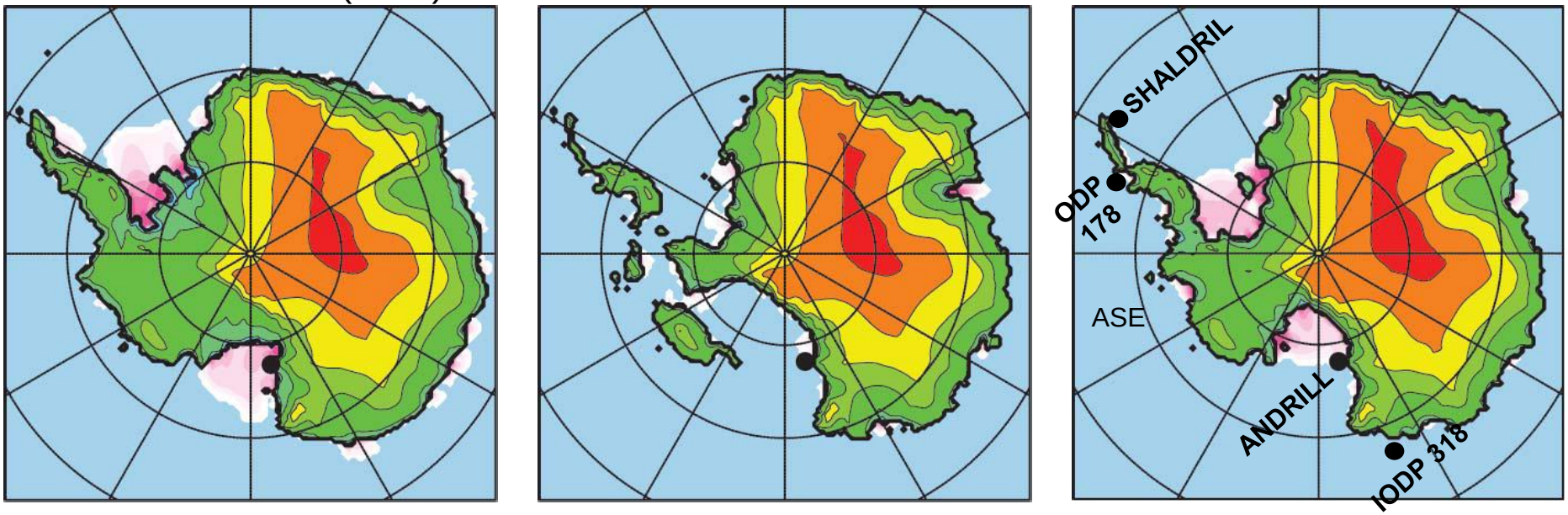


Caltech hot water drill at Upstream B, Antarctica, 1991

Scherer

Caltech system refurbished for WISSARD

Pollard & DeConto (2009)



at 1,094 Ma

at 1,079 Ma

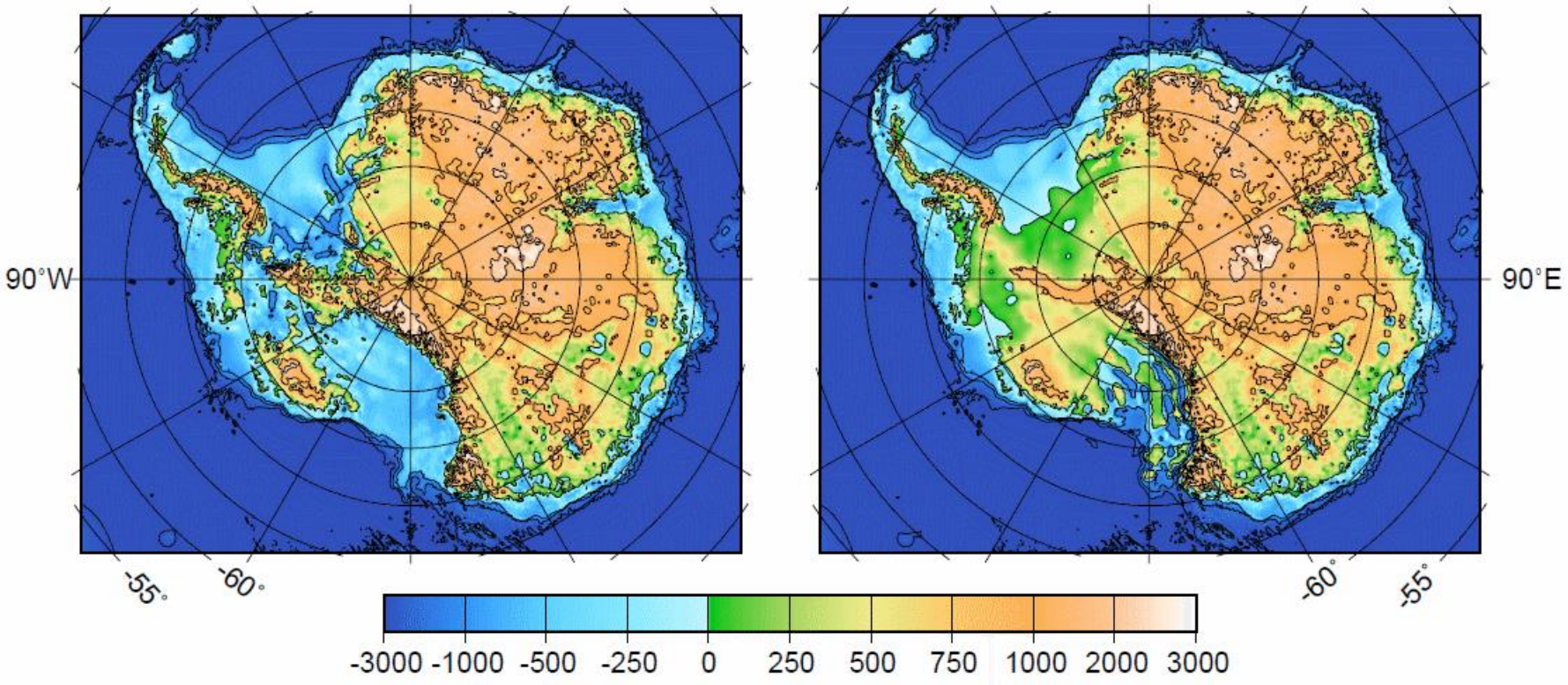
present

- Repeated phases of collapsed WAIS are predicted by modelling under global warming
- ANDRILL AND IODP Exp. 318 show evidence for repeated grounded ice, ice-shelf and open water conditions (superinterglacials) in Ross Sea embayment from Late Miocene to Pliocene
- **Past retreat/collapse processes, causes, rates remain unclear**
- CO2 and SST estimate to lose WAIS. Threshold for irreversible meltdown?
- Other proximal drill data do not exist to verify past partial or full collapses of **marine-based Antarctic Ice Sheet** >> large modelling/prediction uncertainty

Paleo – bathymetric reconstructions

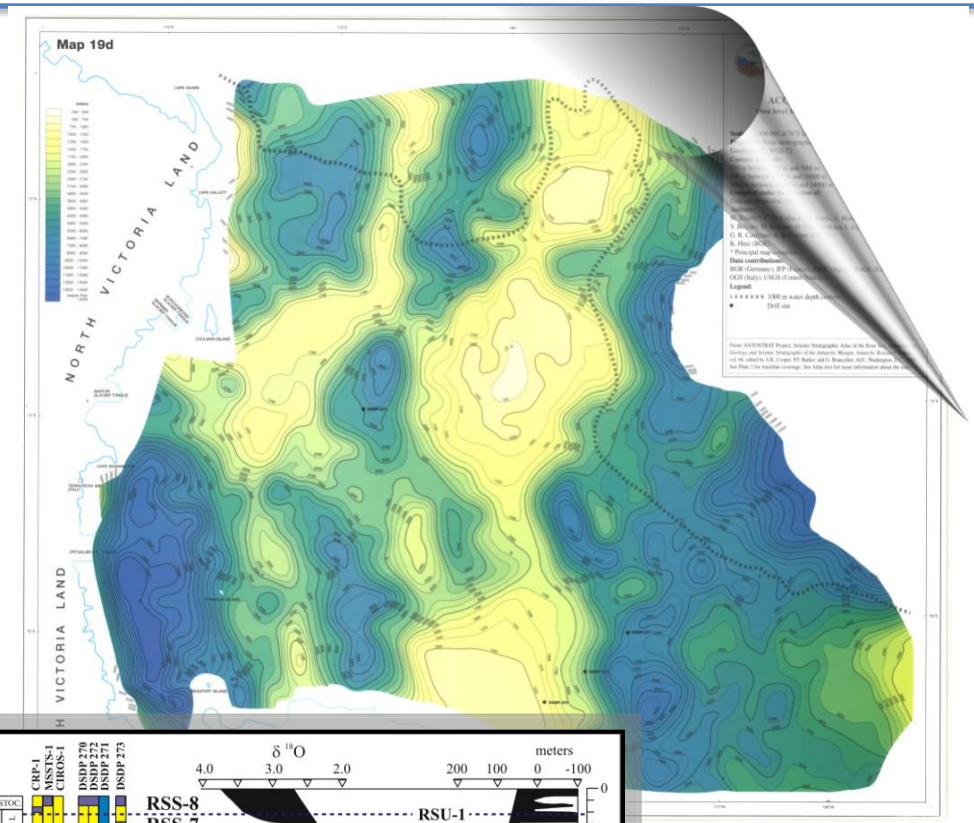
Static view of Antarctica with only the ice sheet removed

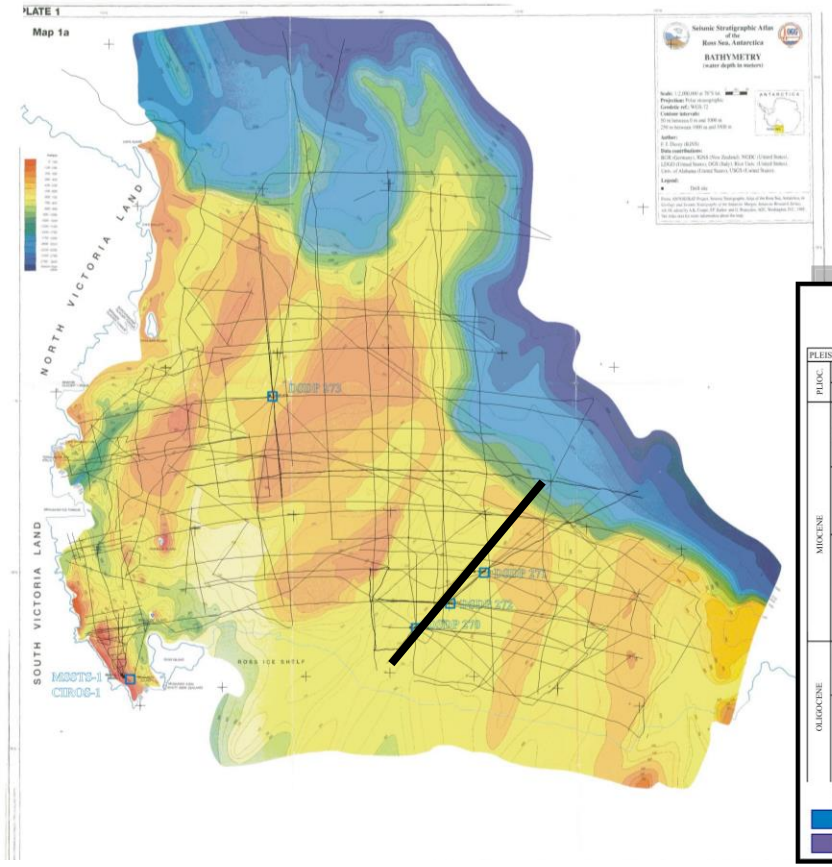
New reconstruction (34 Ma) with the additional landmass.

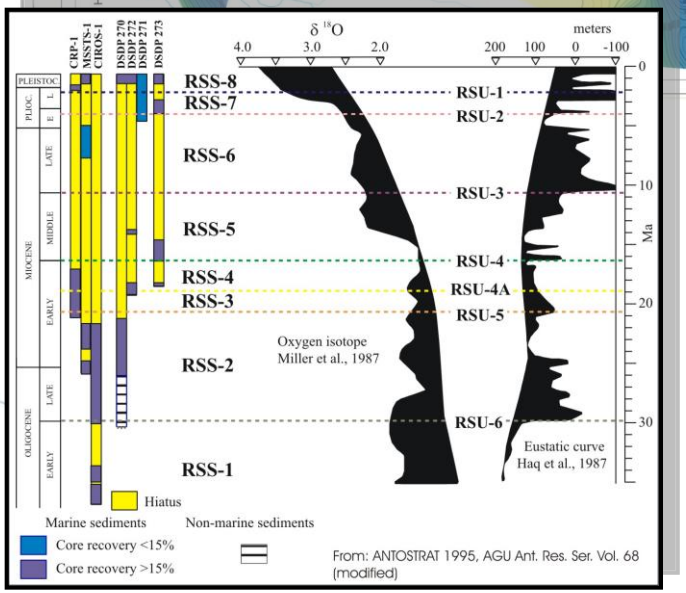


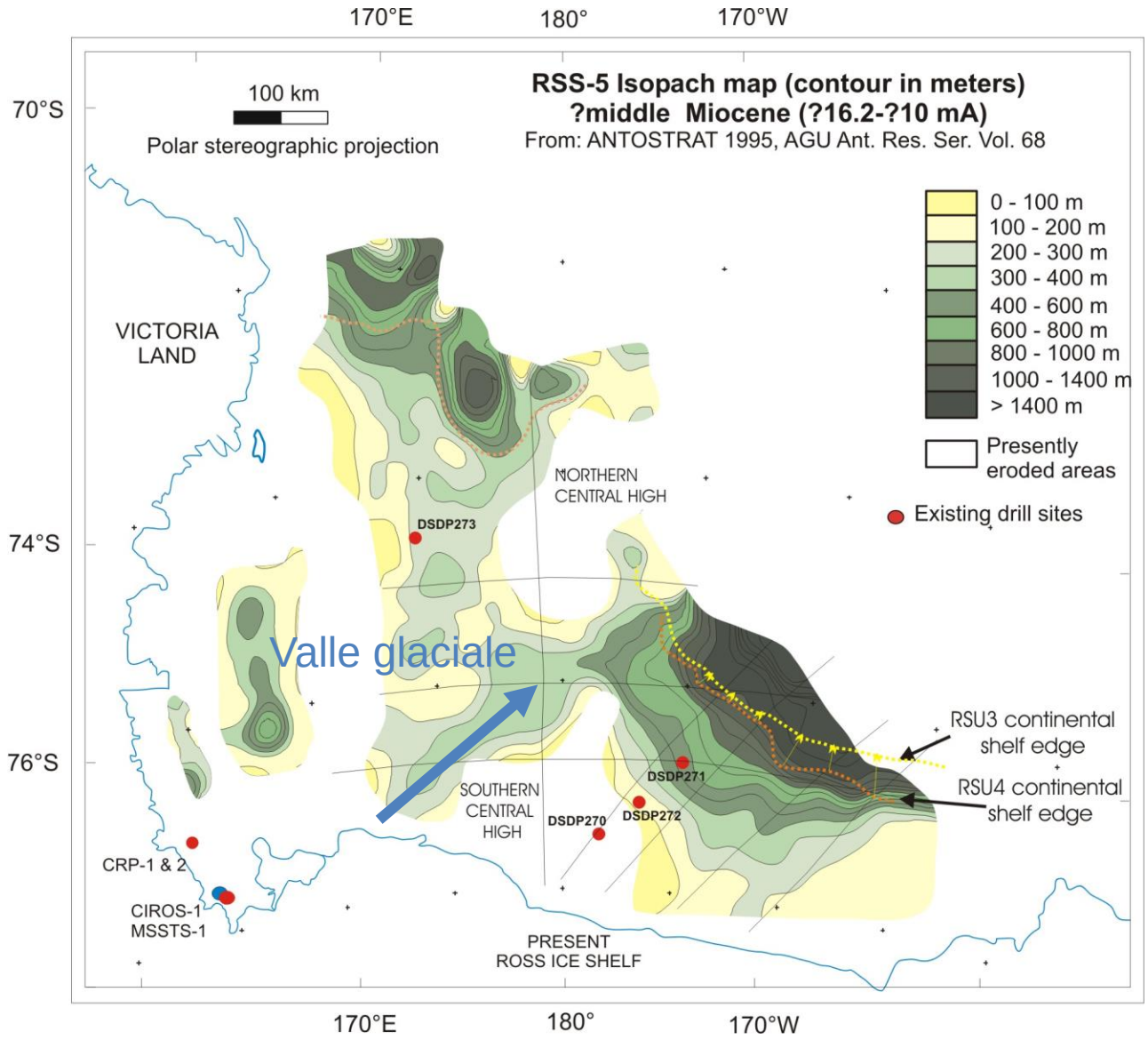
Wilson Luyendyk, 2009. Geophysical Research Letters

Geology and Seismic Stratigraphy of the Antarctic Margin
Alan K. Cooper, Peter. F. Barker, and G. Brancolini, Editors
Antarctic Research Series, Volume 68, 1995. 303 pages, 22 fold-out maps, two CD ROMs

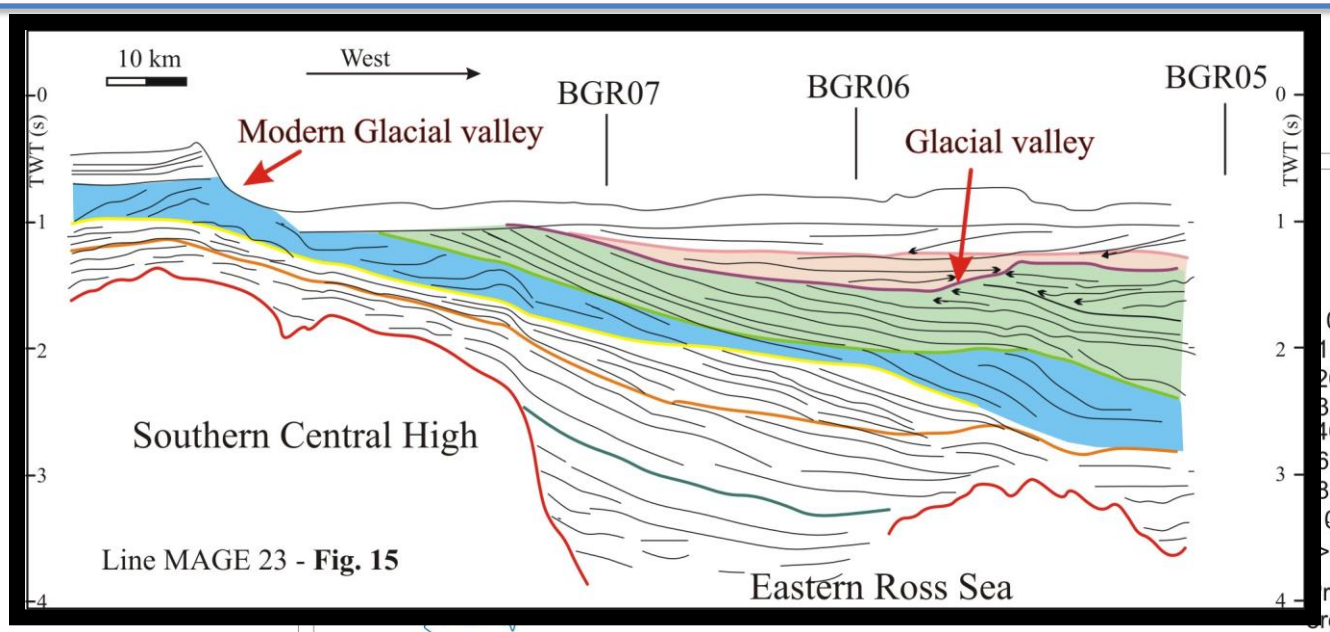




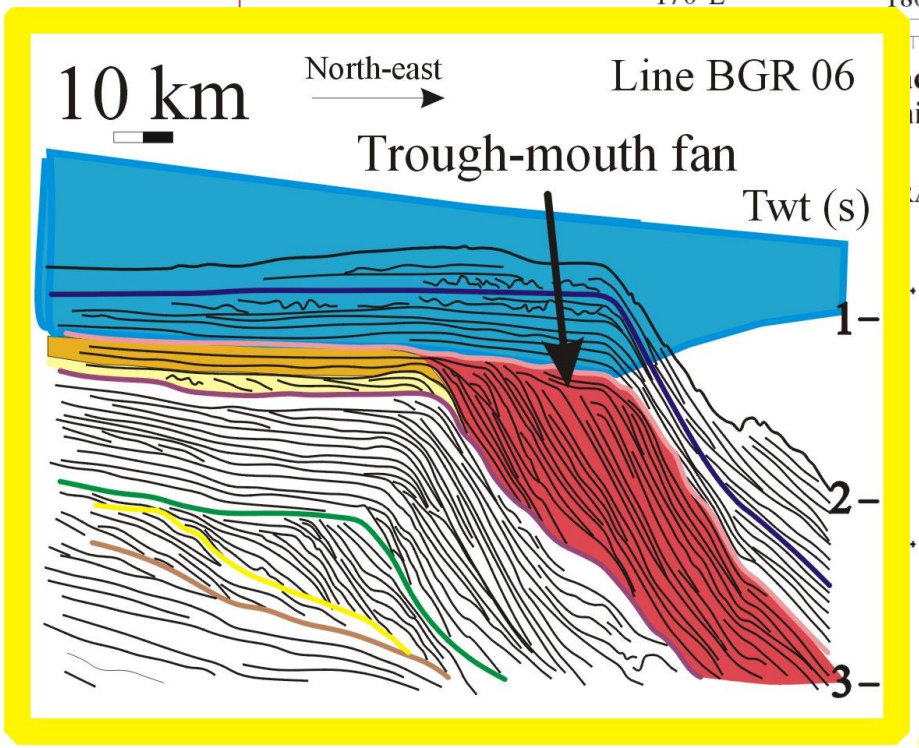




Tra 16 e 10 milioni di anni fa nel Mare di Ross esisteva un ghiacciaio che si estendeva attraverso la piattaforma e che si è poi riempito di sedimento.



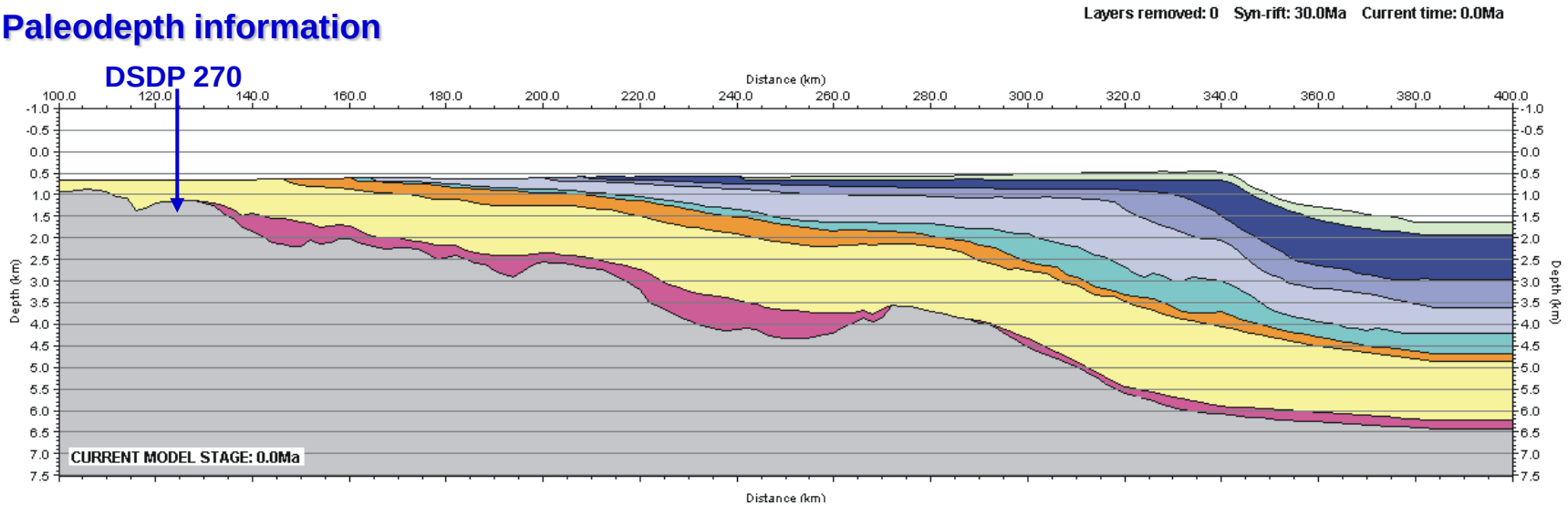
Successivamente si sono formate valli glaciali nel Mare di Ross orientale, incise da ghiacciai provenienti da sud



Che hanno formato grandi trough-mouth

Flexural backstripping of depth converted profile BGR80-07 (Ross Sea) (De Santis et al., 1999)

Paleodepth information

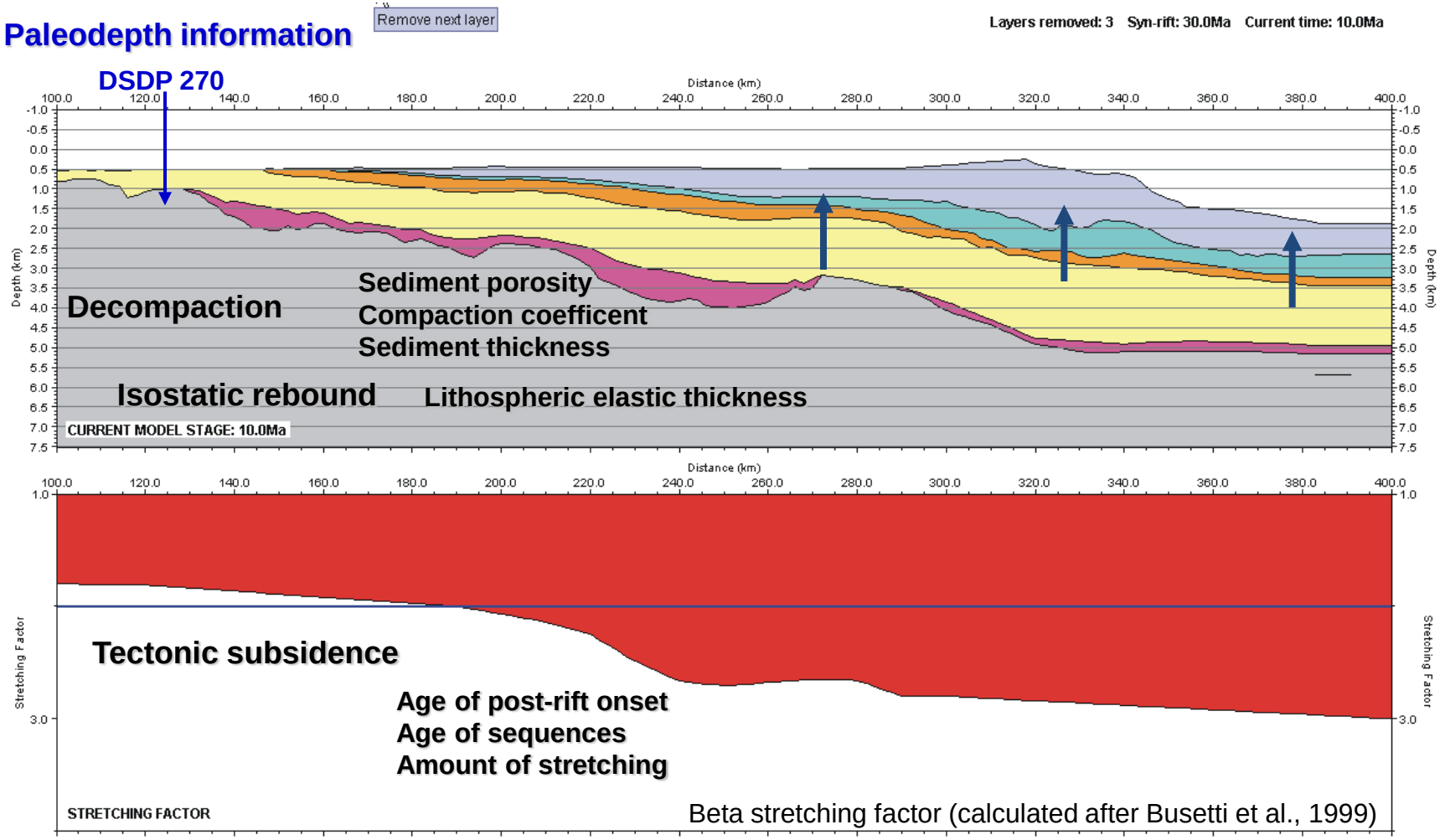


Per ricostruire la paleomorfologia di una zona, ad un certo tempo del passato, oltre a mappare la distribuzione nello spazio degli orizzonti sepolti, occorre anche calcolare di quanto questi orizzonti sono sprofondati per effetto del:

- Peso dei sedimenti sovrastanti
- Della subsidenza tettonica

Flexural backstripping of depth converted profile BGR80-07

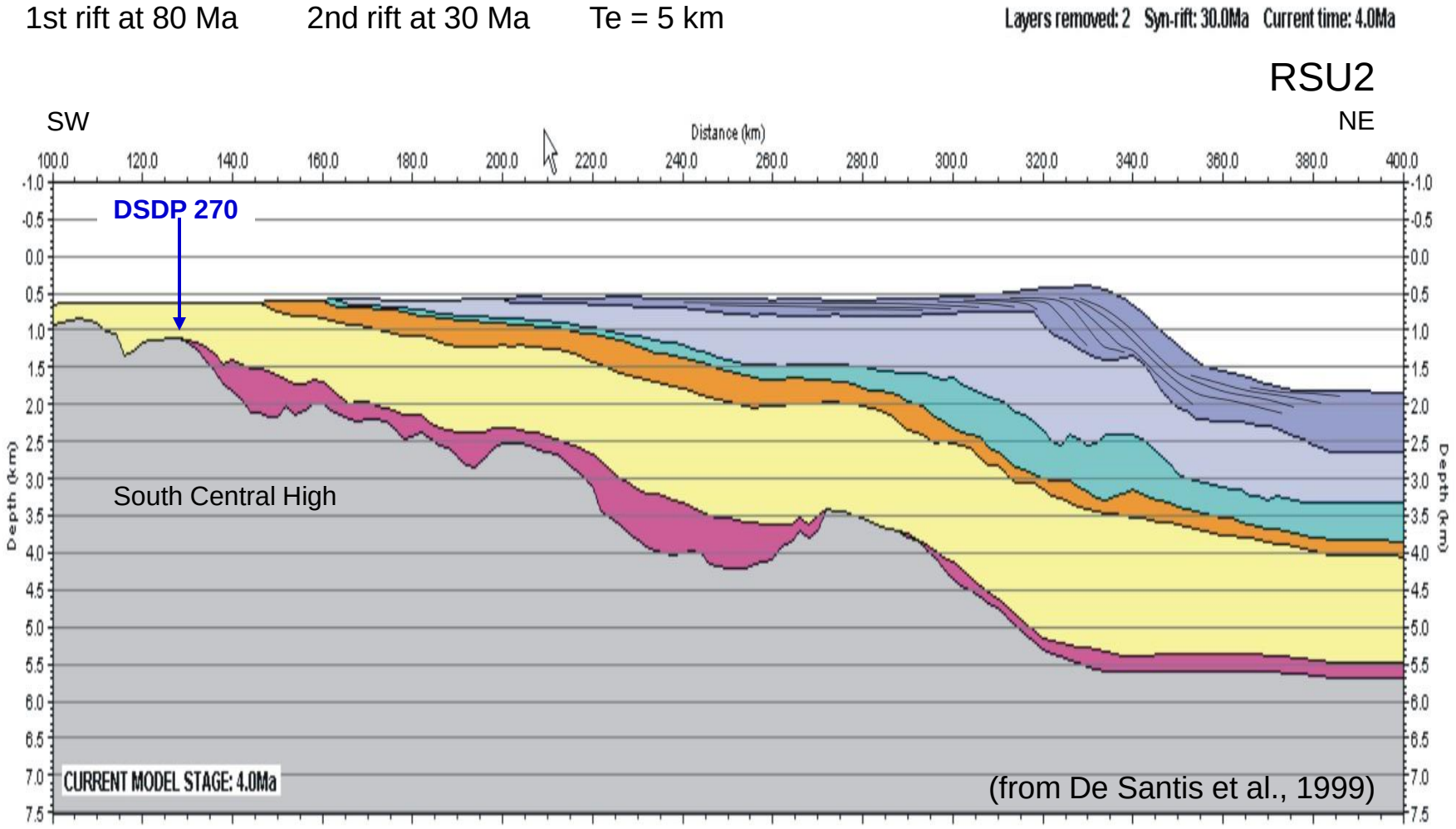
(De Santis et al., 1999)



Beta stretching factor (calculated after Busetti et al., 1999)

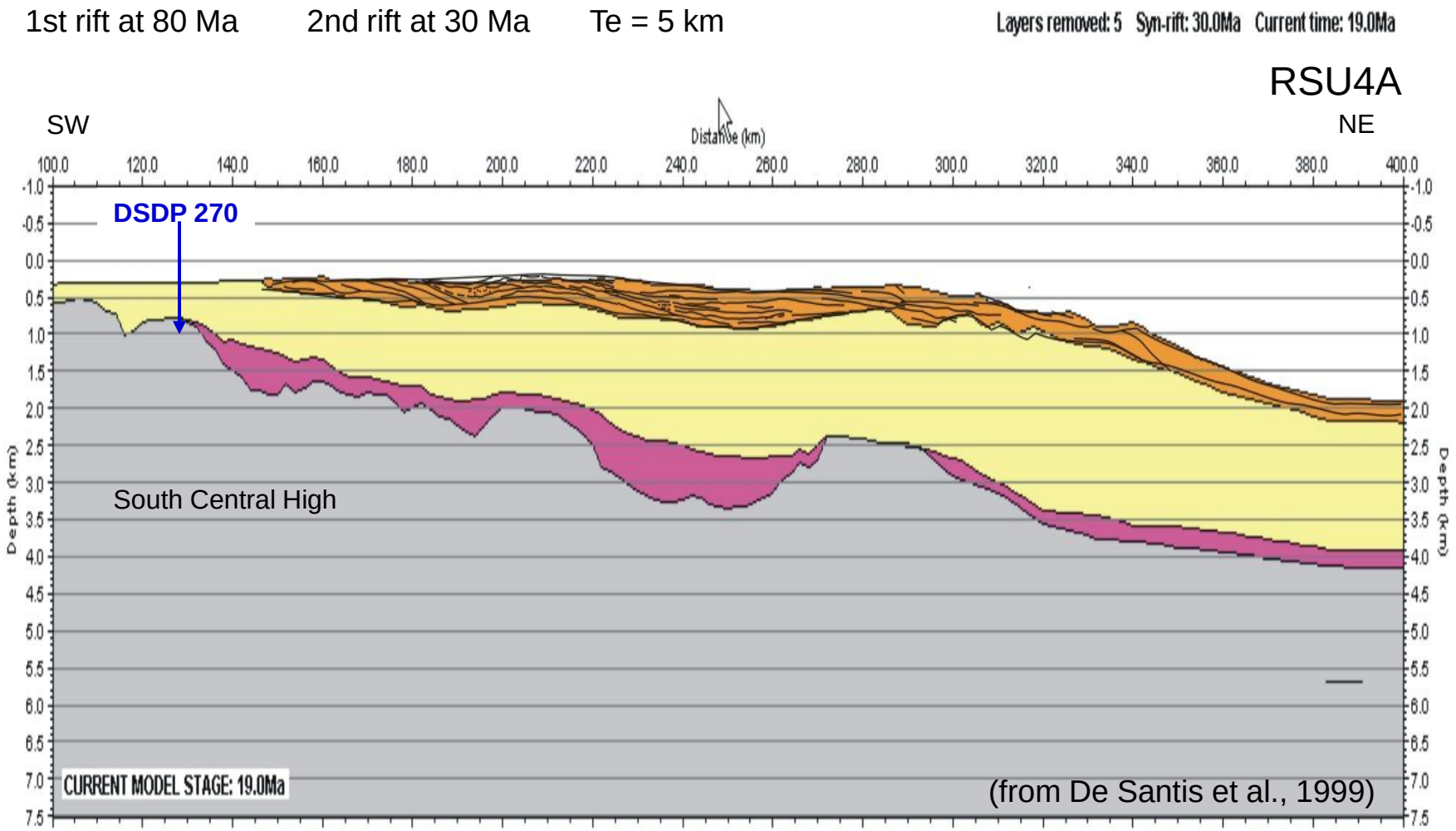
Flexural backstripping of depth converted profile BGR80-07

1st rift at 80 Ma 2nd rift at 30 Ma Te = 5 km



Flexural backstripping of depth converted profile BGR80-07

1st rift at 80 Ma 2nd rift at 30 Ma Te = 5 km



(from De Santis et al., 1999)

Flexural backstripping of depth converted profile BGR80-07

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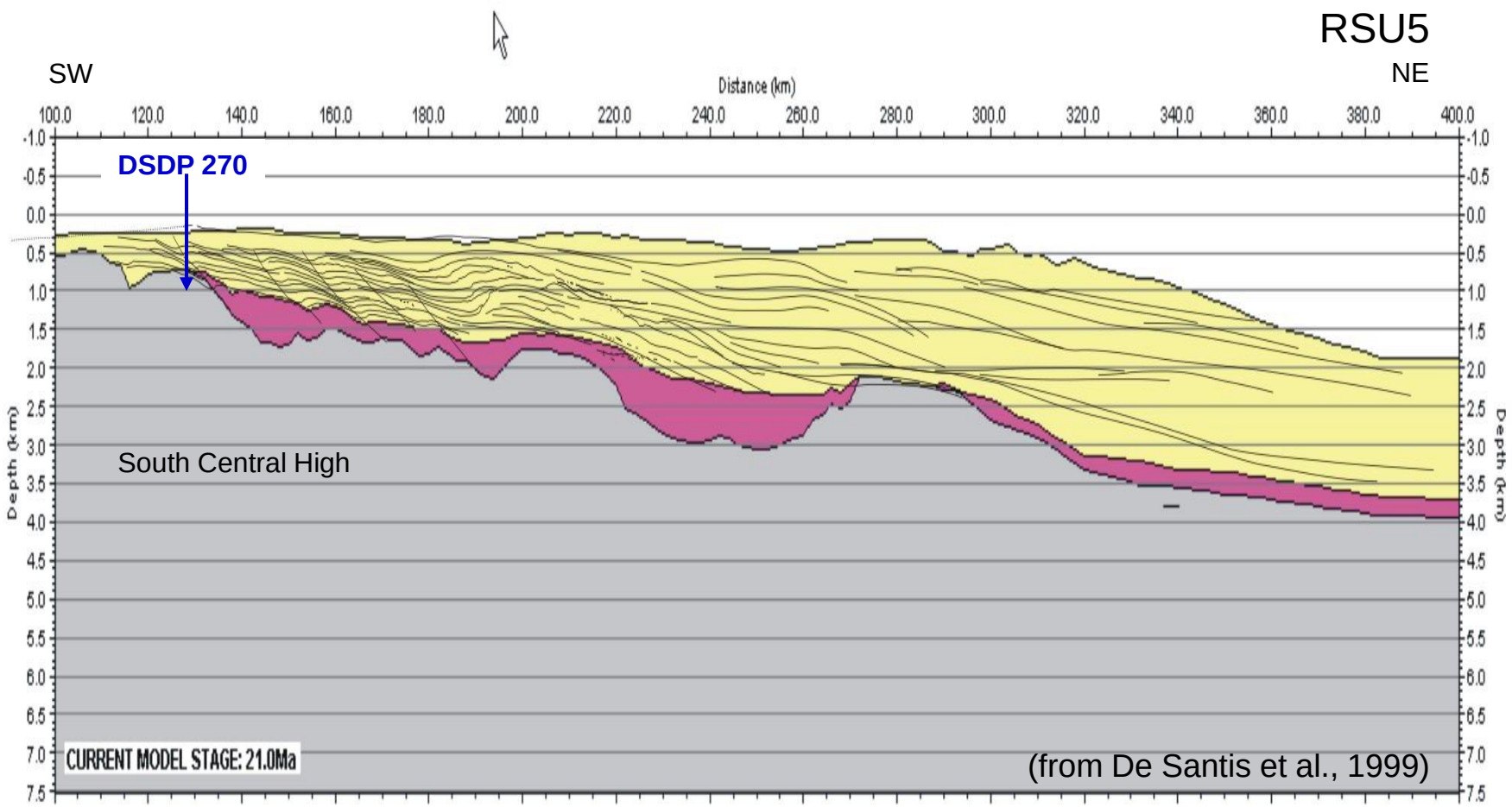

(from De Santis et al., 1999)

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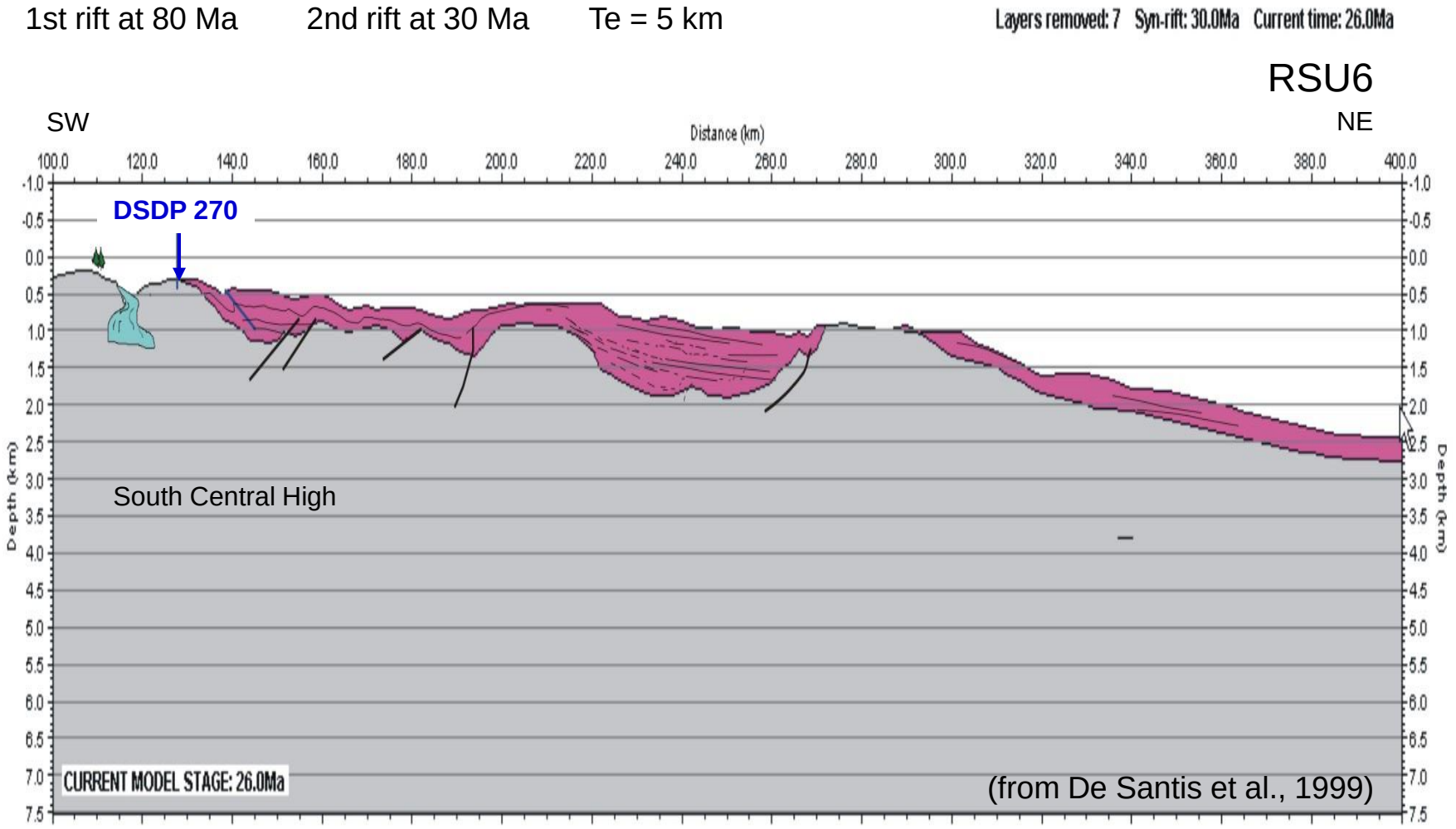
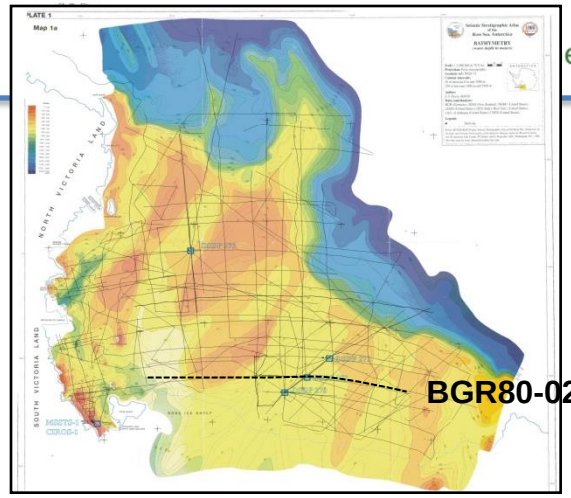
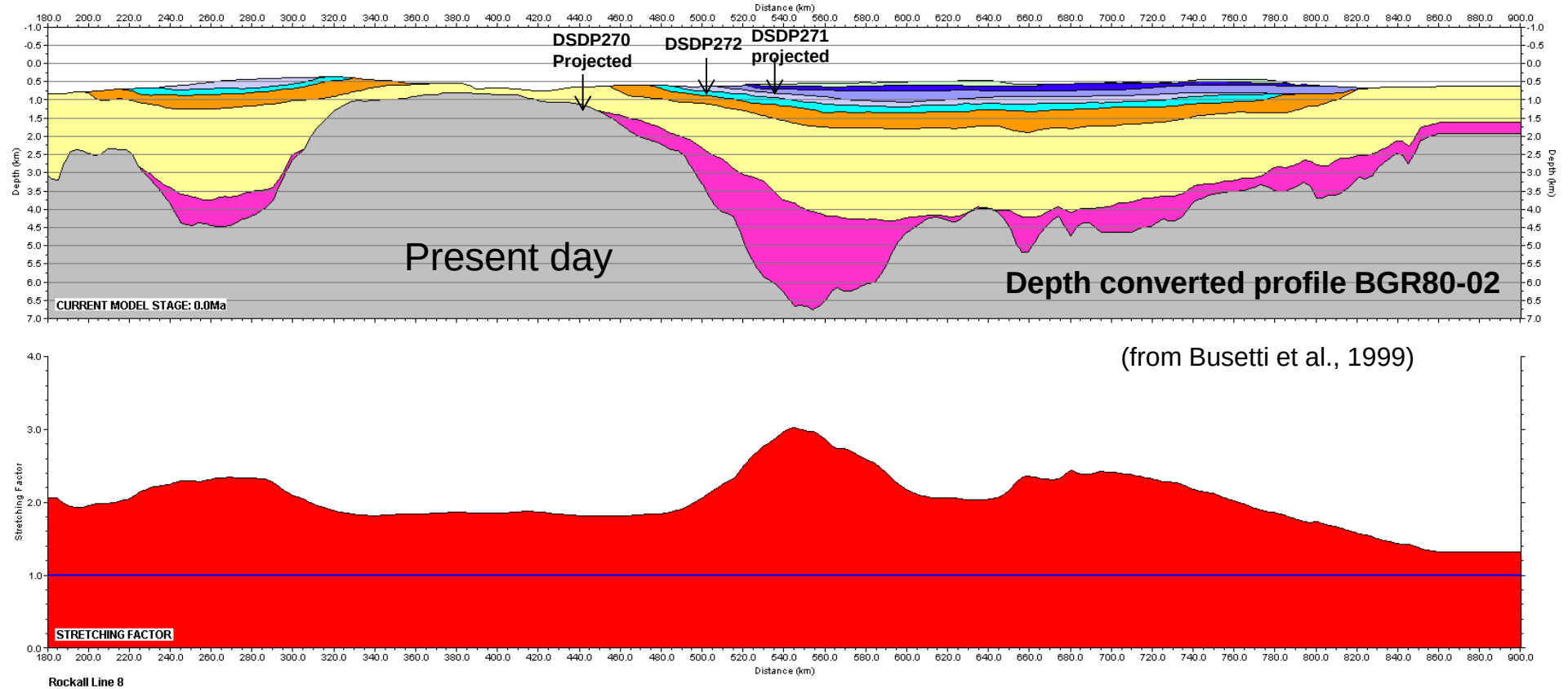


(from De Santis et al., 1999)

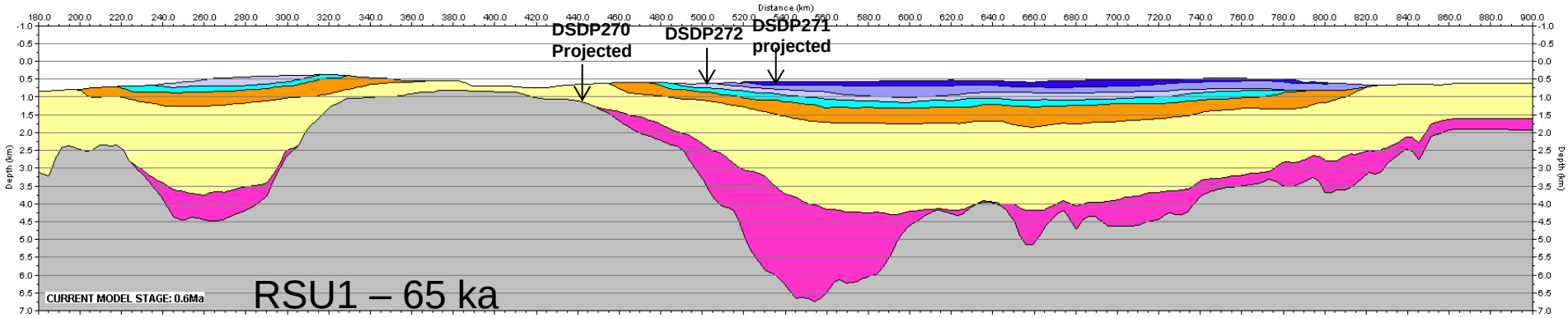


#	Poros (%)	Dec con (1/km)	Dens (g/cc)	Age base (Ma)	Vel (km/s)	Name
1	45.0	0.45	2.6800001	0.6	0.0	Layer_1
2	45.0	0.45	2.6800001	4.0	0.0	Layer_2
3	45.0	0.45	2.6800001	10.0	0.0	Layer_3
4	45.0	0.45	2.6800001	16.5	0.0	Layer_4
5	45.0	0.45	2.6800001	19.0	0.0	Layer_5
6	45.0	0.45	2.6800001	21.0	0.0	Layer_6
7	45.0	0.45	2.6800001	26.0	0.0	Layer_7
8	49.0	0.27	2.6800001	30.0	0.0	Layer_8

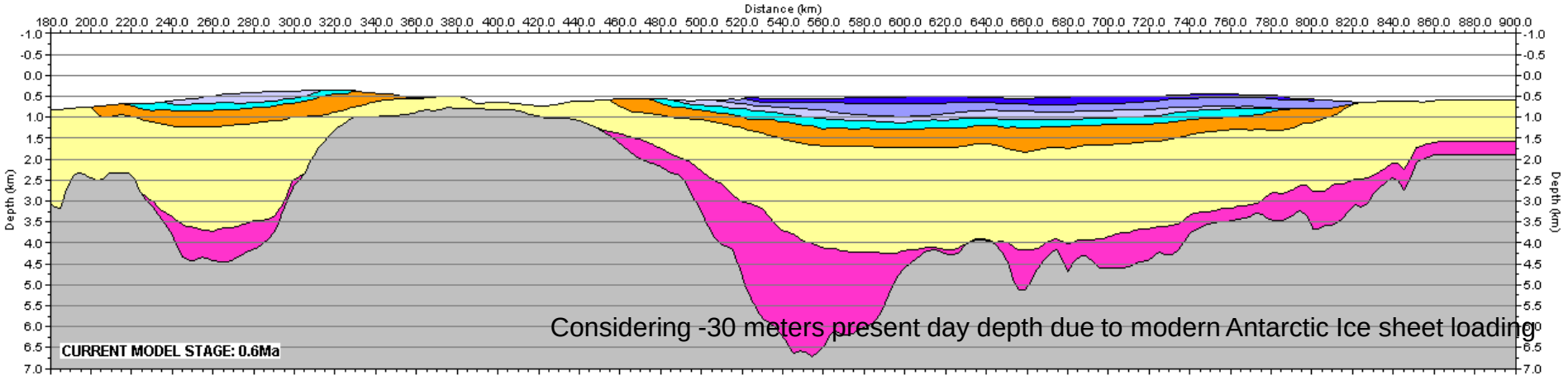
Rift age = 76 Ma
Effective elastic thickness of the Lithoshere = 45 km
Brittle layer thickness= 20 km (moho depth)



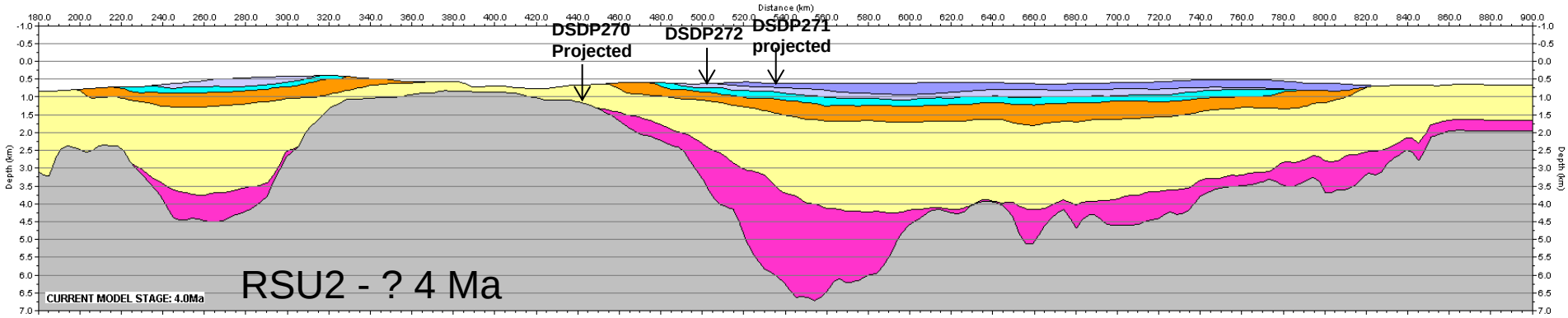
(from Busetti et al., 1999)



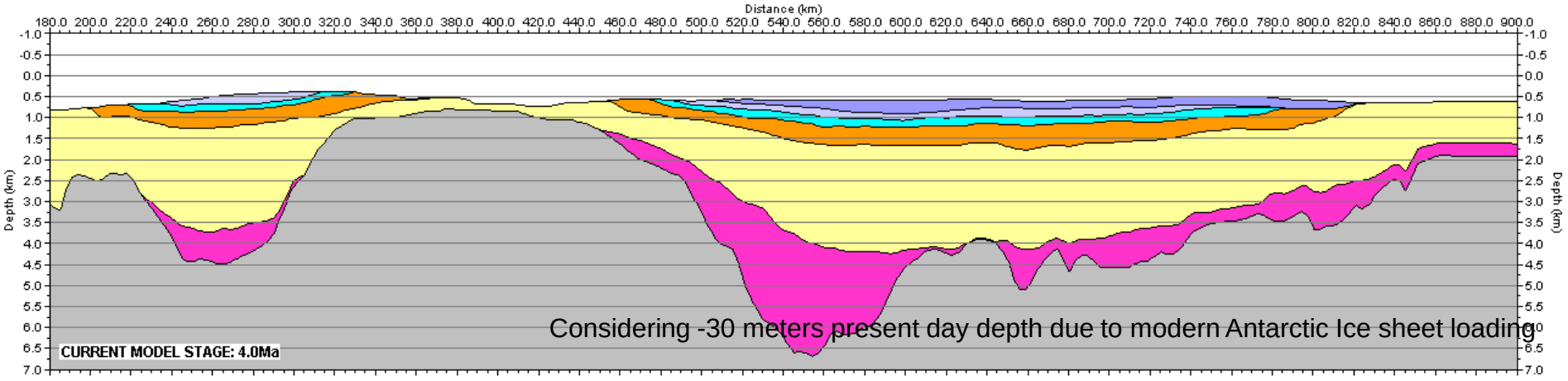
RSU1 – 65 ka



Considering -30 meters present day depth due to modern Antarctic Ice sheet loading



RSU2 - ? 4 Ma



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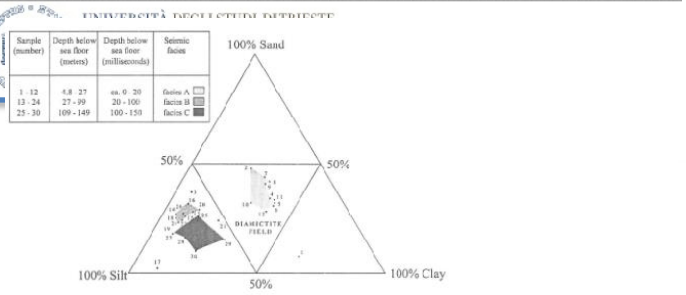


Figure 2. Triangular plot of sand/silt/clay distribution for DSDP Site 272 lithologic units from top of hole to 149 meters below sea floor. Grain size data are from Barnhaw (1981). Shading is same as interpretations in Fig. 1.

TABLE 1. Seismic Data

Type of survey	Seismic source	Seismic source frequency (hertz)	Receiver bandwidth (hertz)	Vertical resolution (meter)	Penetration depth (second)	Scientific institution and year	Seismic survey (km)
single-channel	Sparker 100 J	50-800	no filter	ca. 1.5	0.2	MAGE[1] 1989	3,100
single-channel	Air gun 2.46 l	20-600	50-140	ca. 5	1.5-2.0	Rice University[2] 1990	2,600

[1]Joint Stock Company Marine Arctic Geological Expedition (Russia)
[2]Rice University (USA)

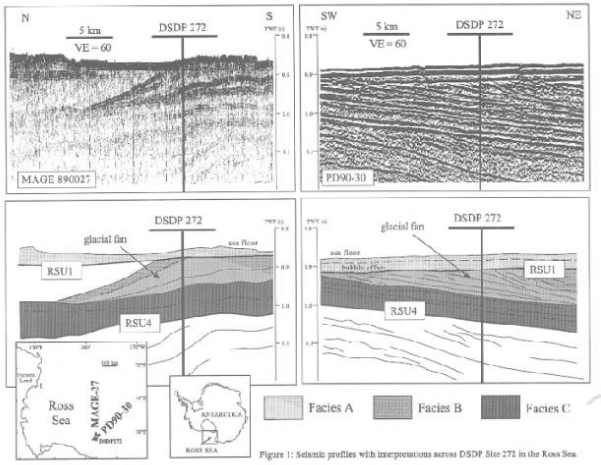
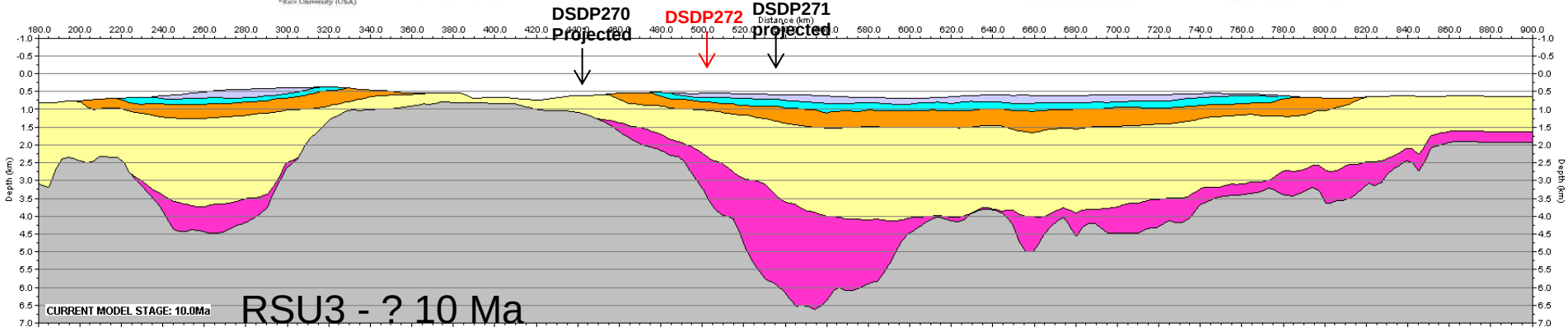
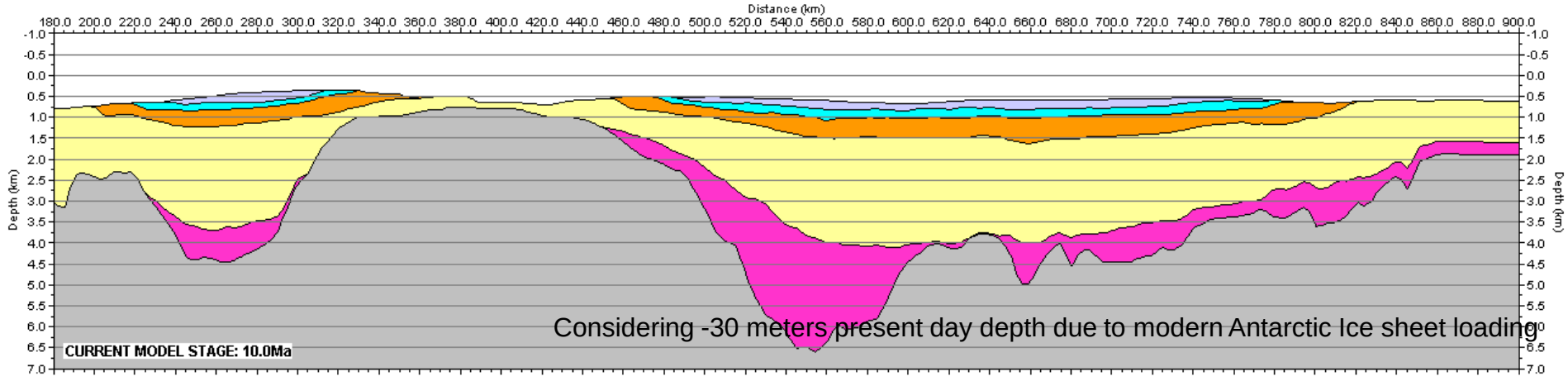


Figure 1: Seismic profiles with interpretations across DSDP Site 272 in the Ross Sea.



RSU3 - ? 10 Ma



Considering -30 meters present day depth due to modern Antarctic Ice sheet loading

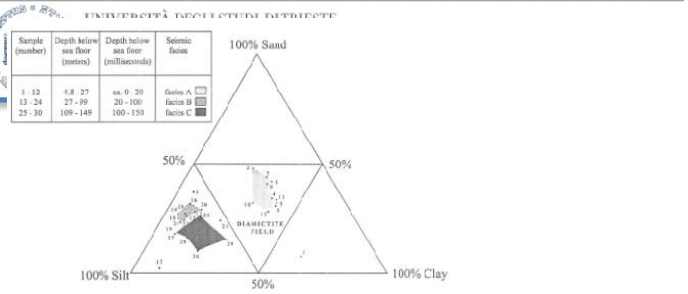


Figure 2. Triangular plot of sand/silt/clay distribution for DSDP Site 272 lithologic units from top of hole to 149 meters below sea floor. Grain size data are from Bainbaw (1981). Shading is same as interpretations in Fig. 1.

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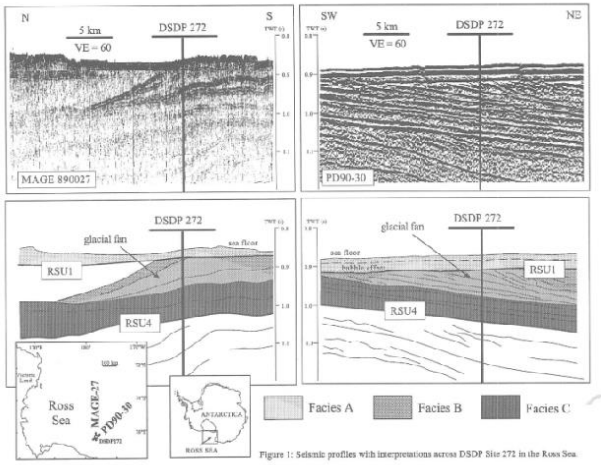

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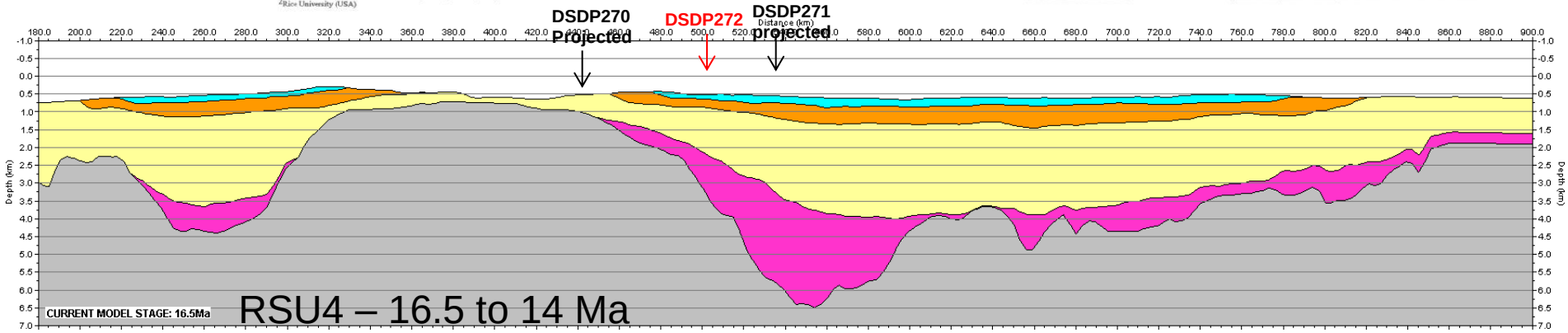
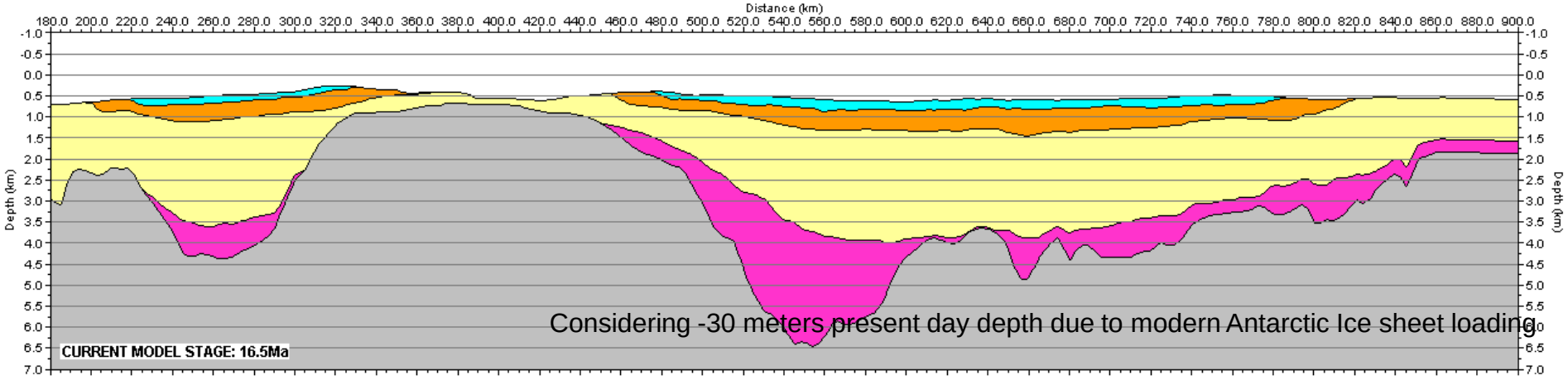
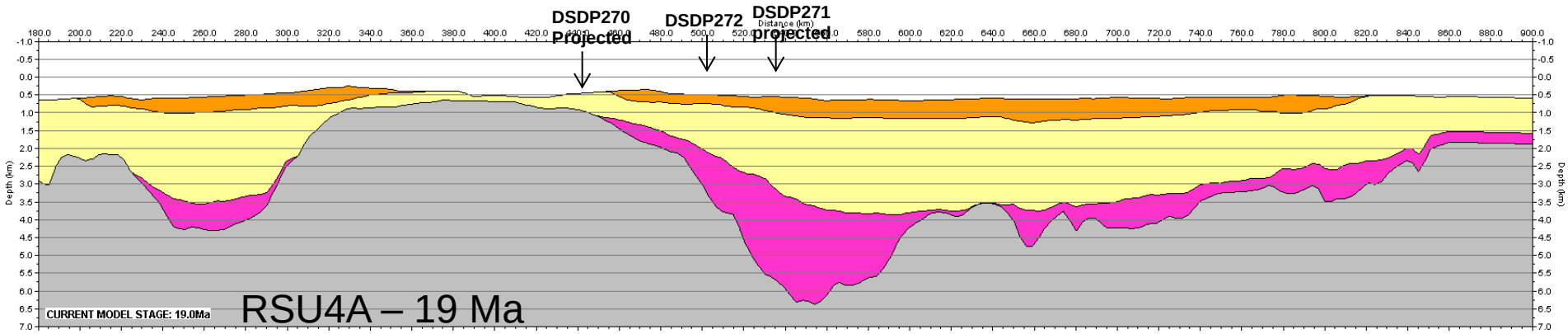


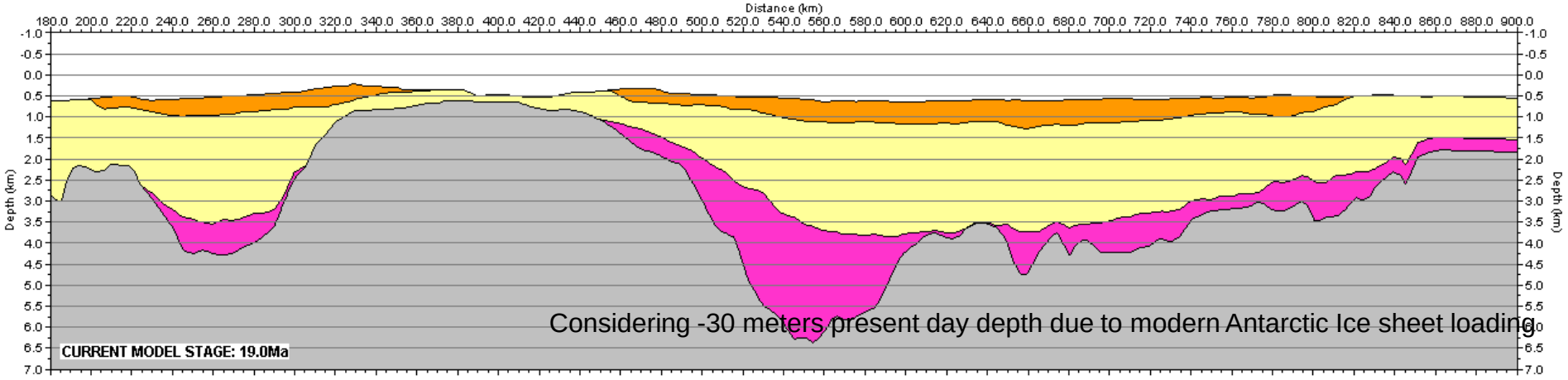
RSU4 – 16.5 to 14 Ma



Considering -30 meters present day depth due to modern Antarctic Ice sheet loading



RSU4A – 19 Ma



Considering -30 meters present day depth due to modern Antarctic Ice sheet loading

PD90-30 (converted in meters)

DSDP270

Cris Karus facies

FA 2: M: Ice distal

FA 4: M: Ice distal and very ice distal

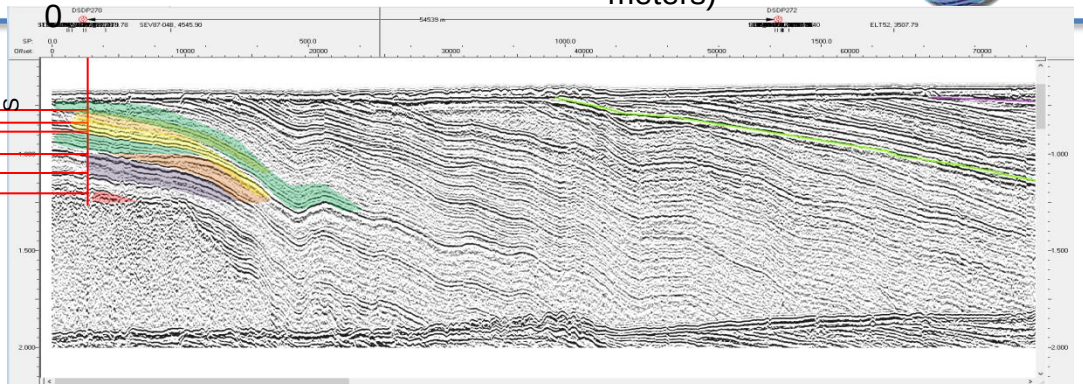
FA 3: D: ice proximal

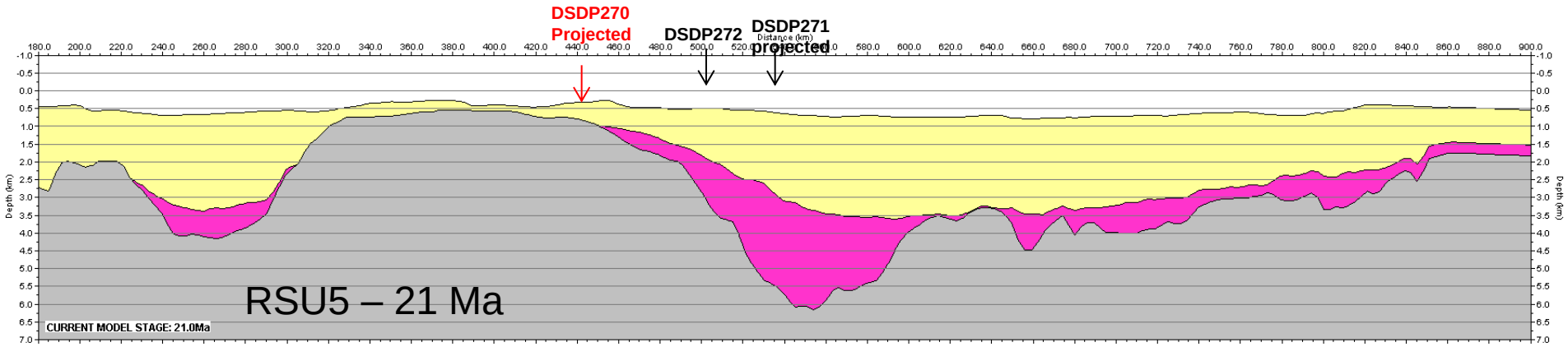
FA 2: M: Ice distal (contourite?)

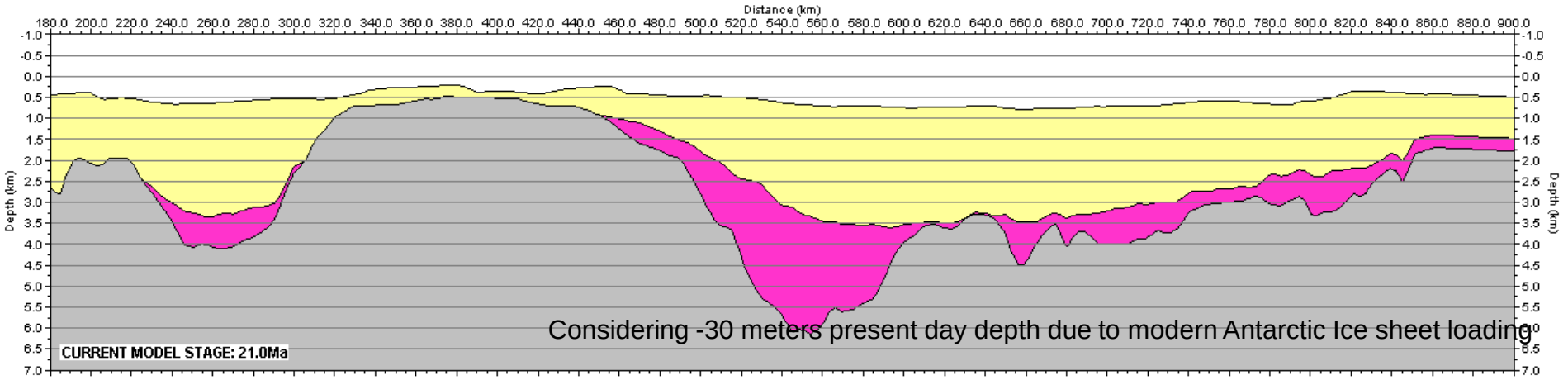
FA 1: Shallow marine

Breccia subaerial/Shallow marine non glacial?

Metamorphic basement







Considering -30 meters present day depth due to modern Antarctic Ice sheet loading

DSDP270

PD90-30 (converted in meters)

Cris Karus facies

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Breccia subaerial/Shallow marine non glacial?

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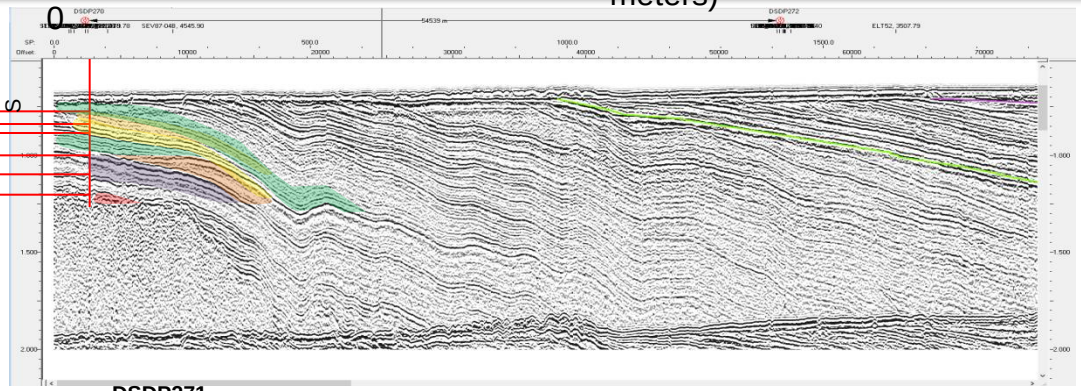
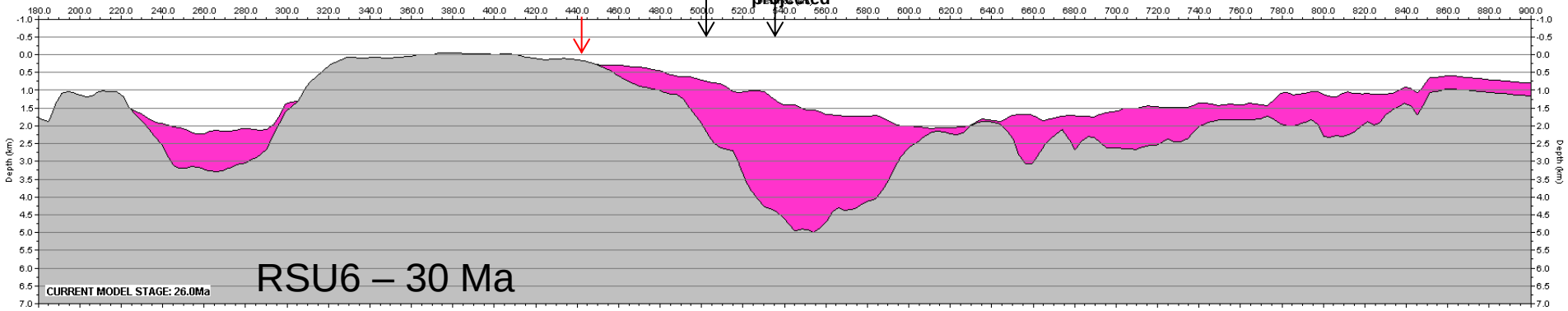
METERS



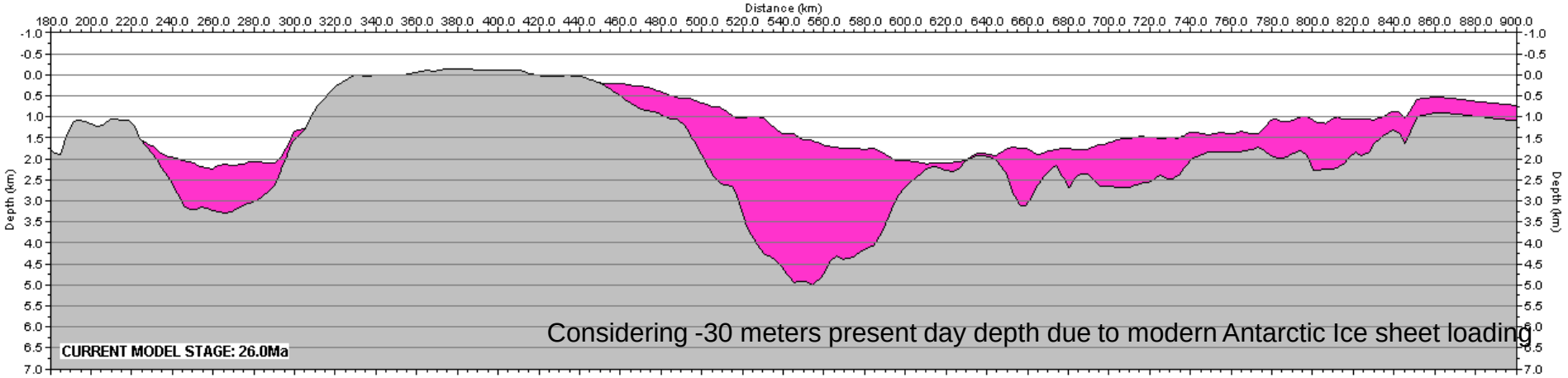
DSDP270 Projected

DSDP272

DSDP271 projected



RSU6 – 30 Ma

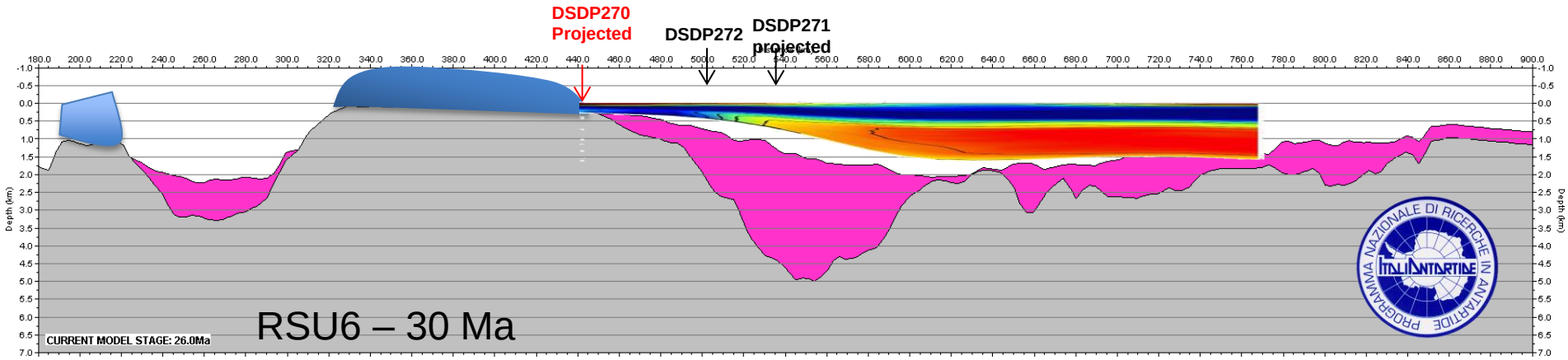


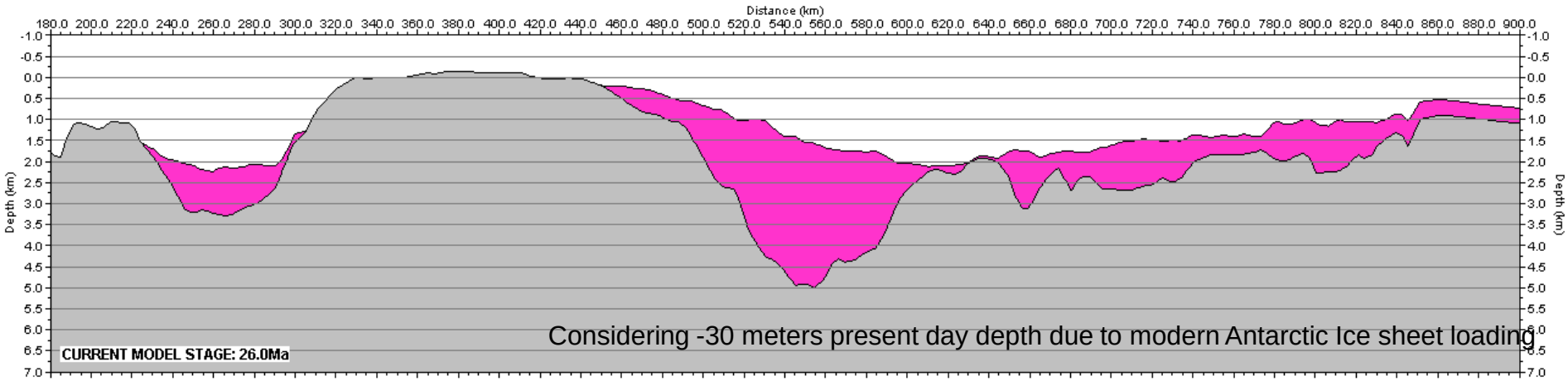
Considering -30 meters present day depth due to modern Antarctic Ice sheet loading

How much (thickness and volume) terrestrial ice existed already?

Ministero degli Affari Esteri
e della Cooperazione Internazionale

How was the water masses stratification? And circulation?

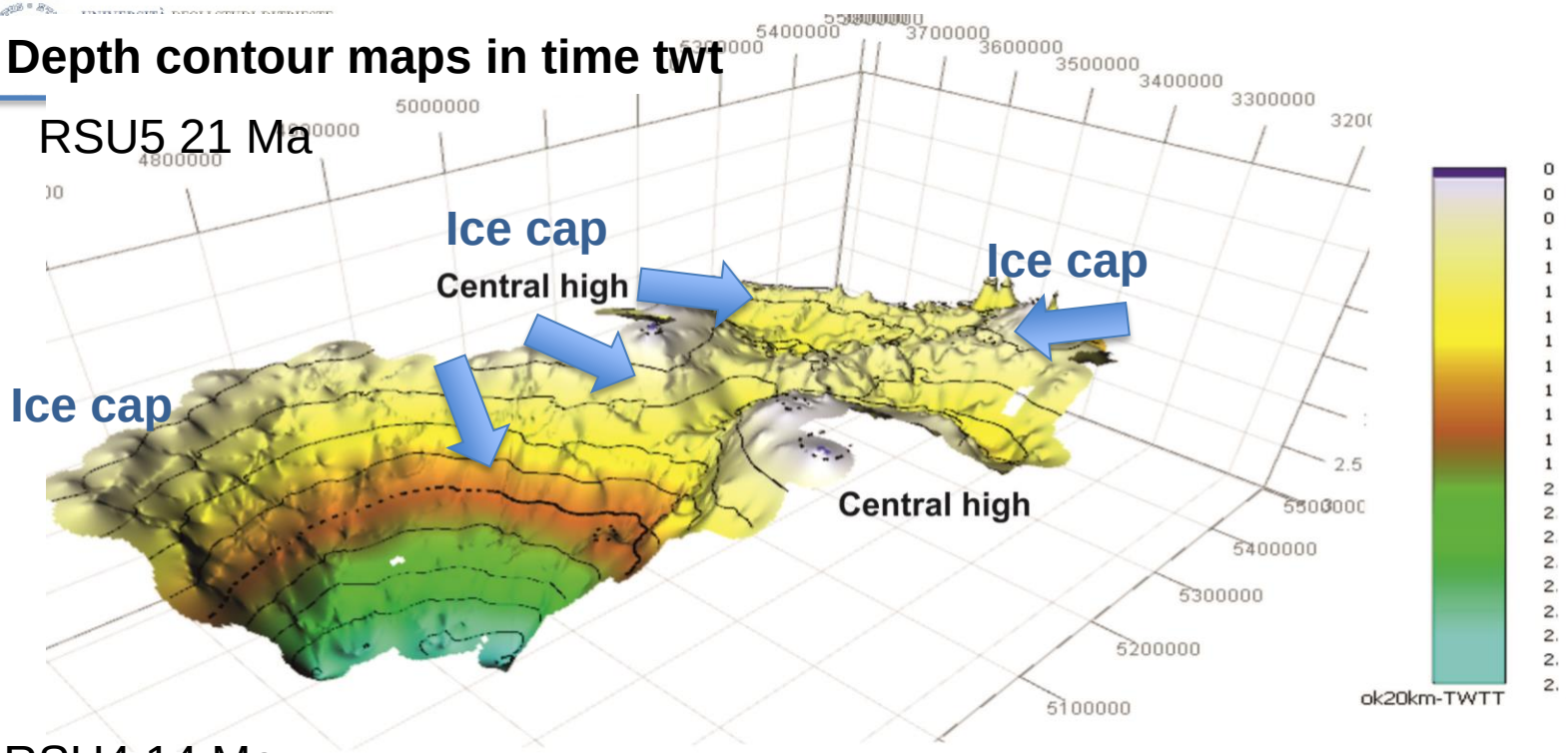




Considering -30 meters present day depth due to modern Antarctic Ice sheet loading

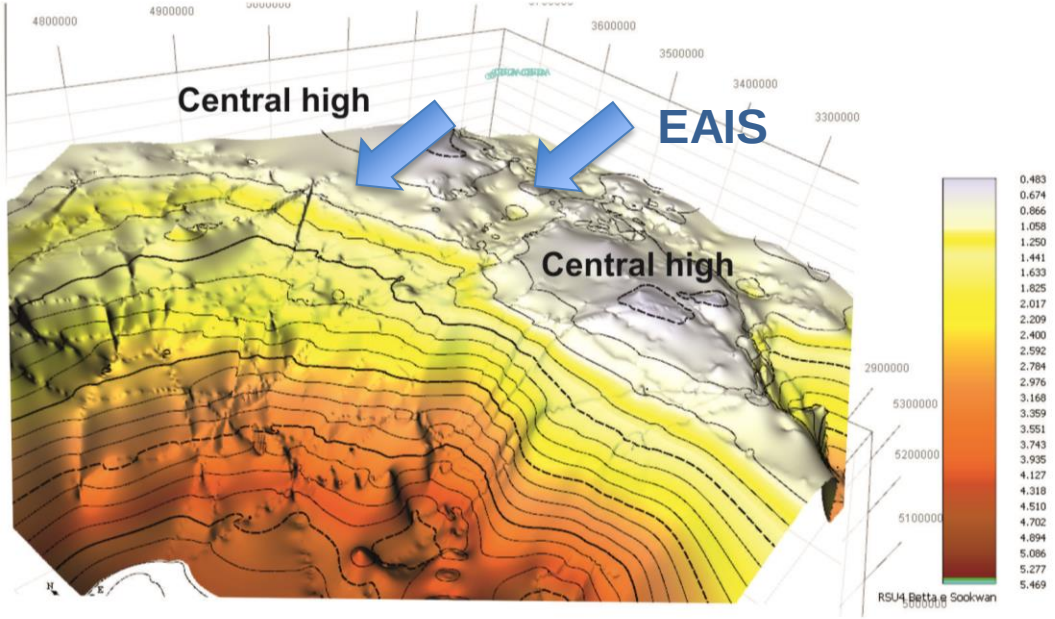
Depth contour maps in time twt

RSU5 21 Ma



New Italian geophysical cruise in the Ross Sea in 2017

RSU4 14 Ma



Present day