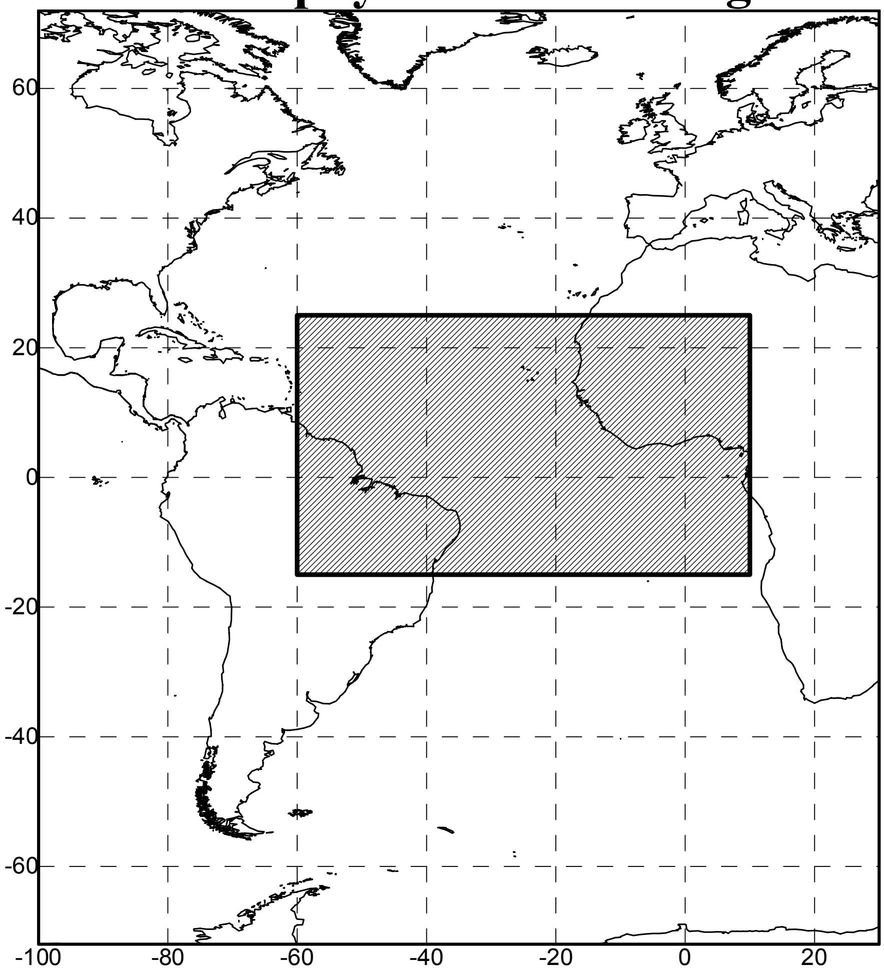
ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

HARD NUT
Laboratory of Geomorphology
and Ocean Floor Tectonics
KREPKIY ORESHEK

Geological-Geophysical Atlas of the Central Atlantic Ocean

Volume I

Common Geophysical and Geological Data



Moscow

Contents

Conventional density variations in crust layer. *Sokolov S.Yu., Mazarovich A.O.*

List 21.
Horizontal gradient of gravity isostatic anomalies. *Sokolov S.Yu.*

List 22.
Horizontal gradient of gravity isostatic anomalies. *Sokolov S.Yu.*

List 23.
Anomalous magnetic field. *Sokolov S.Yu.*

List 24.
Magnetization. *Sokolov S.Yu.*

List 25.
Acoustic basement and deep seismic sounding data. *Sokolov S.Yu.*

List 26.
Thickness of sediments between bottom and reflection horizon D (~25 Ma) and linear magnetic anomalies. *Sokolov S.Yu.*

List 27.
Thickness of sediments between reflection horizons D and Ac (from ~25 Ma to ~49 Ma) and linear magnetic anomalies. *Sokolov S.Yu.*

List 28.
Thickness of sediments between reflection horizons Ac and A* (from ~49 Ma to ~68 Ma) and linear magnetic anomalies. *Sokolov S.Yu.*

List 29.
Thickness of sediments between reflection horizons A* and β (from ~68 Ma to ~112 Ma) and linear magnetic anomalies. *Sokolov S.Yu.*

List 30.
Thickness of sediments between reflection horizons β and J (from ~112 Ma to ~129 Ma) and linear magnetic anomalies. *Sokolov S.Yu.*

List 31.
Thickness of sediments between reflection horizon J and acoustic basement (from ~129 Ma) and linear magnetic anomalies. *Sokolov S.Yu.*

List 32.
Cluster combinations of geophysical parameters with geodynamical interpretation. *Sokolov S.Yu., Sokolov N.S.*

Data Sources

1. GEBCO-97 Digital Atlas CD. IHO. Natural Environment Research Council.
2. Deep Sea Drilling Project CD. NOAA Product # G01336-CDR-A0001.
3. Ocean Drilling Program CD. NOAA Product # G01013-CDR-A0001.
4. Sandwell D.T., Smith W.H.F. Marine Gravity Anomaly from Geosat and ERS-1 Satellite Altymetry. // J. geophys. Res. 1997. Vol. 102. N B5. p. 10039-10054. (ftp://topex.ucsd.edu/pub/)
5. ETOPO5 Set. Global Relief Data CD. NOAA Product # G01093-CDR-A0001.
6. Marine Trackline Geophysical Data CD. NOAA Product # G01321-CDR-A0001.
7. Agapova G.V., Vinogradova N.V., Kashnikova I.P. Dictionary of Undersea Feature Names. M.: Geological Institute RAS. 1993. 311 p.
8. Gazetteer of Undersea Feature Names. 2-nd Edition. IHO. IOC. Monaco. 1997. 123 p.
9. Atlas of Oceans: Atlantic and Indian Oceans.//Ed. by Gorshkov S.G. GUNIO. DM USSR. 1977. 306 p.

10. International Geological-Geophysical Atlas of Atlantic Ocean.//Ed. Udintsev G.B. IHO (UNESCO). USSR Ministry of Geology. USSR Academy of Sciences. GUGK USSR. Moscow. 1990. 158 p.
11. Smith W. H. F., Sandwell D. T. Global Seafloor Topography from Satellite Altimetry and Ship Depth Soundings. Science 1997 Sept. 26. 277 (5334). (ftp://topex.ucsd.edu/pub/, http://edcwww.cr.usgs.gov/landdaac/gtopo30/)
12. EGM96 Joint Earth Geopotential Model. NASA-NIMA. 1996. (http://cddis.gsfc.nasa.gov/ 926/egm96/egm96.html)
13. GTOPO30 Global Digital Elevation Model. EROS Data Center. 1996. (http://edcwww.cr.usgs.gov/landdaac/gtopo30/gtopo30.html).
14. ArcWorld 1:3M. ESRI ArcDATA set CD. 1992.
15. Mueller R.D., Roest W.R., Royer J.-Y., Gahagan L.M., Sclater J.G. Digital age map of the ocean floor. SIO Reference Series 93-30. (ftp://baltica.ucsd.edu/pub/global_age/)
16. Carte tectonique internationale de l'Afrique. 1:5000000. A.A.G.A. UNESCO. 1968.
17. Tectonic Map of South America. 1:5000000. DNPM-CGMW-UNESCO. 1978
18. Lemoine F.G. et al. The Development of the NASA GSFC and DMA Joint Geopotential Model. International Symposium on Gravity, Geoid and Marine Geodesy (GraGeoMar96). Univ. of Tokyo. Tokyo. Japan. Sept. 30 - Oct. 5. 1996. Geoid Undulation Grid from EGM96. NASA-NIMA. 1996. (http://cddis.gsfc. nasa.gov/926/egm96/egm96.html)
19. Harvard University Centroid-Moment Tensor Catalog. December 1997. (http://www.seismology.harvard.edu/CMTsearch.html)
20. Louvari E.K., Kiratzi A.A. RAKE: a windows program to plot earthquake focal mechanisms and the orientation of principal stresses. Computers & Geosciences. 1997. vol.23. no.8 pp. 851-857.
21. Cande S.C., LaBrecque J.L., Larson R.L., Pitman W.C. III, Golovchenko X., Haxby W.F. Magnetic Lineations of World's Ocean Basins (map), Amer. Ass. Petrol. Geol., Tulsa. OK. 1989. Digitized Set by G. Cole, 1993. Global Relief Data CD. NOAA Product # 1093-A27-001.
22. CNSS Earthquake Composite Catalog. June 1997 (http: //quake.geo.berkeley.edu/cnss/)
23. Pollack H.N., Hurter S.J., Johnson J.R. New Global Heat Flow Compilation. Univ. Of Michigan. Dep. Of Geol. Sciences. Ann Arbor. Michigan 48109-1063. USA. 1991.
24. Maus S., Rother M., Holme R., Luhr H., Olsen N., Haak V. First scalar magnetic anomaly map from CHAMP satellite data indicates weak lithospheric field. Geophysical Research Letters. V. 29. N 14. 10.1029/2001 GL013685. 2002. (http://www.gfz-potsdam.de/pb2/pb23/SatMag/litmod3.html)
25. Tucholke B.E., Uchupi E. Thickness of Sedimentary Cover. // International Geological-Geophysical Atlas of Atlantic Ocean. Ed. Udintsev G.B. IHO (UNESCO). USSR Ministry of Geology. USSR Academy of Sciences. GUGK USSR. Moscow. 1990. p.122-125.
26. Laske G., Masters G. A Global Digital Map of Sediment Thickness. EOS Trans. AGU. 78. F483. 1997. (http://mahi.ucsd.edu/Gabi/sediment.html)
27. Lamont-Doherty Earth Observatory. Deep-Sea Sample Repository. Search from September 1, 1998. (http://www.ldeo.columbia.edu/CORE_ REPOSITORY/RHP1.html)
28. Hannington M. Hydrothermal Vent Database. Inter-Ridge Databases. 2001.(http://triton.ori.u-tokyo.ac.jp/~intridge/data1.html)
29. Zoback M. L., Burke K. World Stress Map. EOS. 1993. WSM Database – 2001. (http://www-wsm.physik.uni-karlsruhe.de/pub/stress_data/stress_data_frame.html)
30. Grand S.P., van der Hilst R.D., Widiyantoro S., Global seismic Tomography: A snapshot of convection in the Earth, GSA Today ,7 ,1 –7, 1997.
31. Dmitriev L.V., Sokolov S.Y., Plechova A.A. Statistical Assessment of Variations in the Compositional and P-T Parameters of the Evolution of Mid-Oceanic Ridge Basalts and Their Regional Distribution // Petrology. 2006. Vol.14. #3. P.227-247.
32. Klein E.M., Langmuir C.H. Global correlation of ocean ridge basalt chemistry with axial depth and crustal thickness // Journal Geophysical Research. 1987. B-92. P. 8089-8115.

33. Dmitriev L.V., Sokolov S.Yu., Melson W. G., O'Hirn T. Plum and Spreading Basaltic Associations and their Reflection in Petrological and Geophysical Parameters of Mid Atlantic Ridge Northern Part. // Russian Journal of Earth Sciences. 1999. November. V. 1. #. 6. P. 457-476.

34. Sokolov S.Yu., Mazarovich A.O. Gas Hydrates in the Sedimentary Cover of Passive Oceanic Margins: Possibilities of Prediction Based on Satellite Altimetry Data in the Atlantic and Arctic // Lithology and Mineral Resources. 2009. Vol. 44. No. 5. pp. 441–450.

35. Sandwell D.T., Smith W.H.F. Marine Gravity from Geosat and ERS 1 Satellite Altimetry // J. Geophys. Res. 1997. V. 102. N. B5. P. 10039-10054

36. GPS Time Series Data. Jet Propulsion Laboratory of California Institute of Technology. 2008. (http://sideshow.jpl.nasa.gov/mbh/series.html)

37. Maus S. et al. EMAG2: A 2-arc-minute resolution Earth Magnetic Anomaly Grid compiled from satellite, airborne and marine magnetic measurements // Geochemistry Geophysics Geosystems (G3), 10, Q08005. 2009. Vol.10. N.8.

38. Larson E., Ekström G., Tromp J., 1999, Seismology group, Department of Earth and Planetary Sciences, Harvard University, http://www.seismology.harvard.edu

39. Maus S., Rother M., Holme R., Luhr H., Olsen N., Haak V. First scalar magnetic anomaly map from CHAMP satellite data indicates weak lithospheric field // Geophysical Research Letters, VOL. 29, NO. 14, 10.1029/2001GL013685, 2002

40. Deep Seismic Sounding of the Lithosphere on Angolo-Brazilian Geotraverse. M.: UIFZ RAS, 1996. 108 p.

41. Panaev V.F., Mitulov S.N. Seismic stratigraphy of Atlantic ocean Sedimentary cover. M.: Nedra, 1993. 247 p.

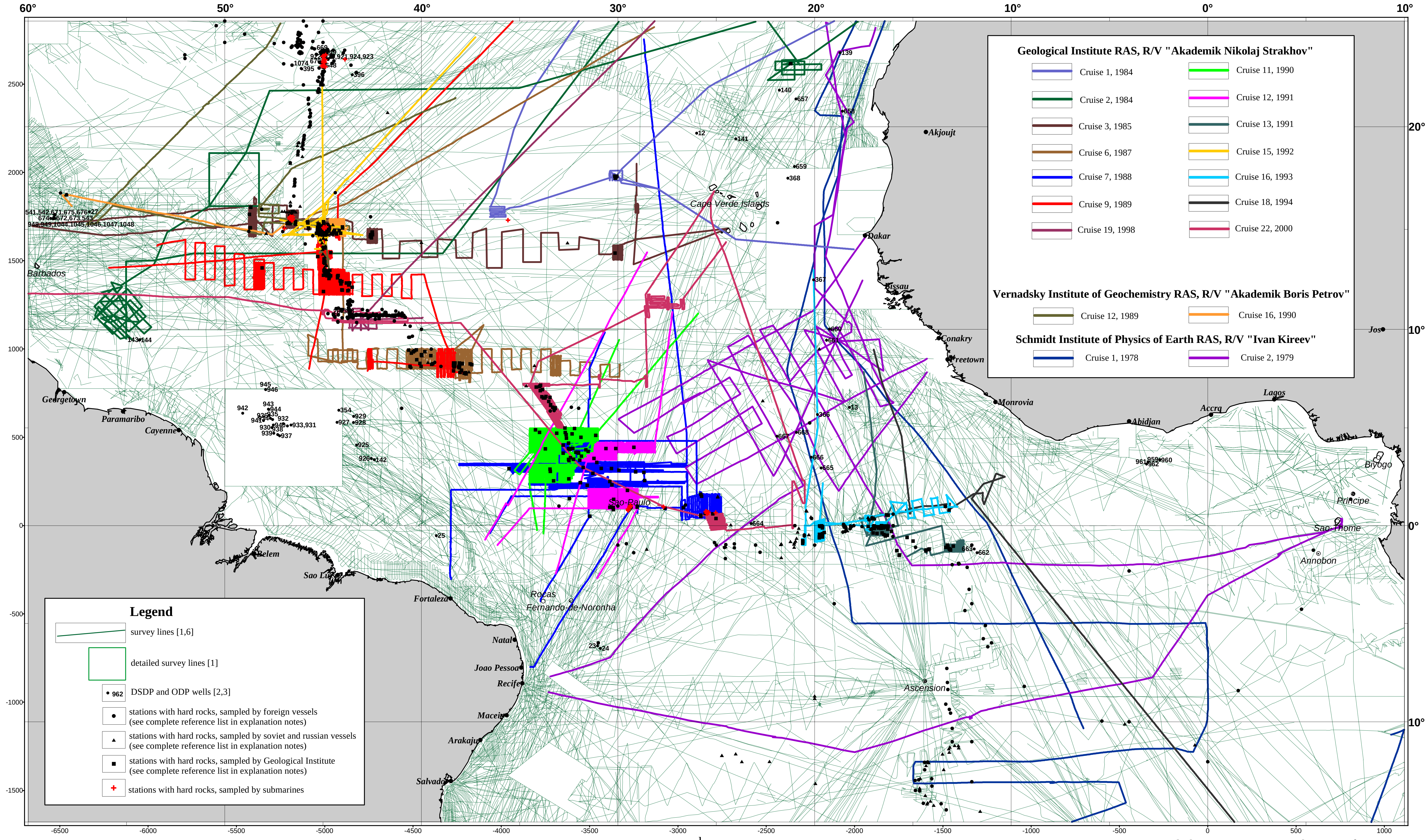
42. Sokolov S.Y. Condition of geodynamic mobility in mantle based on data from seismic tomography and P and S waves velocity ratio // Bulletin of Kamchatka Regional Association "Educational-Scientific Center". Earth Sciences. 2014. № 2 (24). C. 55-67.

43. Sokolov S.Yu., Sokolov N.S., Dmitriev L.V. Geodynamic zonation of the Atlantic Ocean lithosphere: Application of cluster analysis procedure and zoning inferred from geophysical data // Russian Journal of Earth Sciences. 2008. V. 10. ES4001, doi:10.2205/2007ES000218. P.1-30

Scheme of Surveys and Stations at Central Atlantic Conducted by Geological Institute RAS.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



km

0 200 400 600 800

Scale 1:20000000 by Equator

List 1.

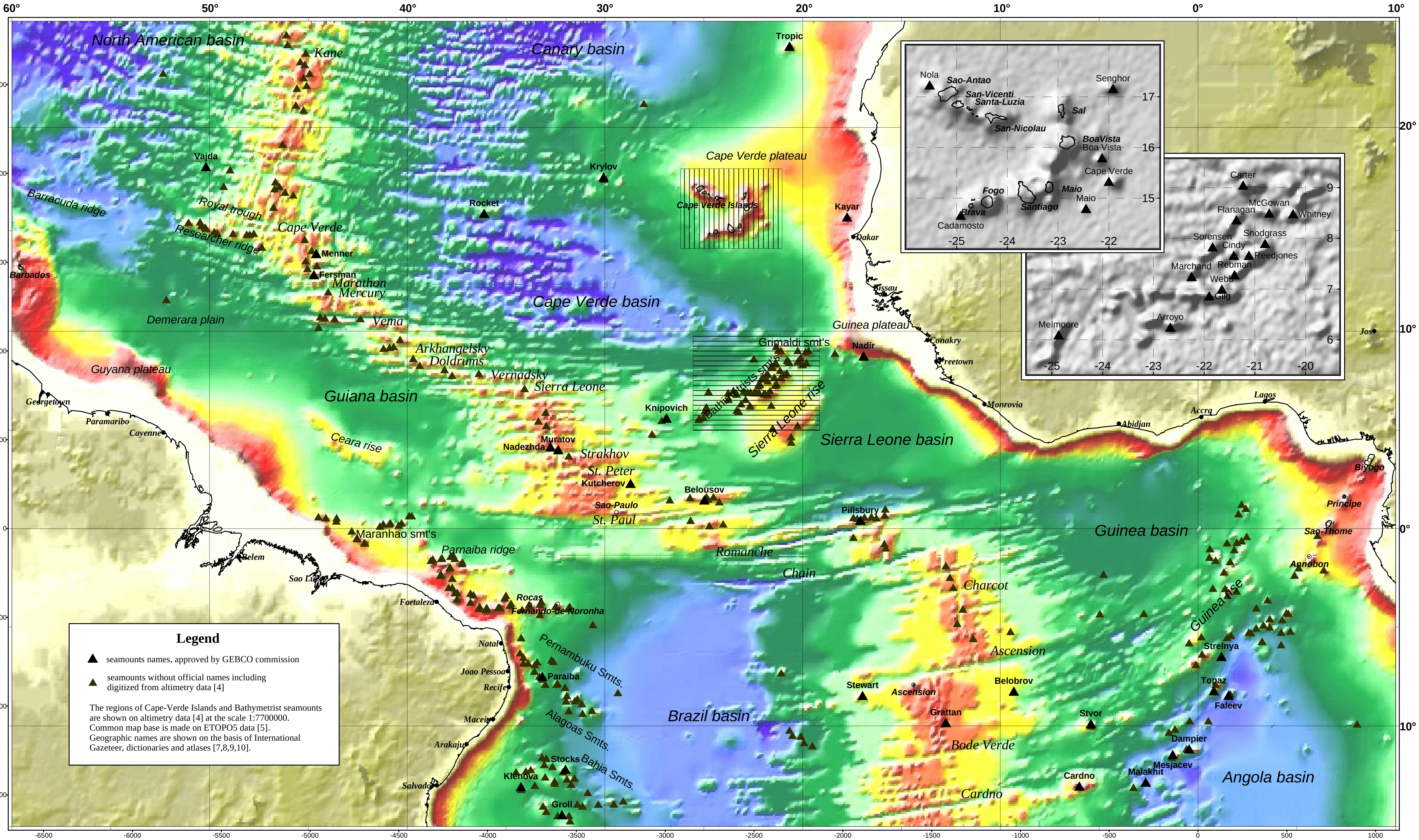
Sokolov S.Yu., Mazarovich A.O., Efimov V.N.

2000

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

Physical-Geographical Map of Central Atlantic.

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



List 2. *Mazarovich A.O., Agapova G.V., Sokolov S.Yu., Turko N.N.*

1999

km

0 200 400 600 800

Scale 1:20000000 by Equator

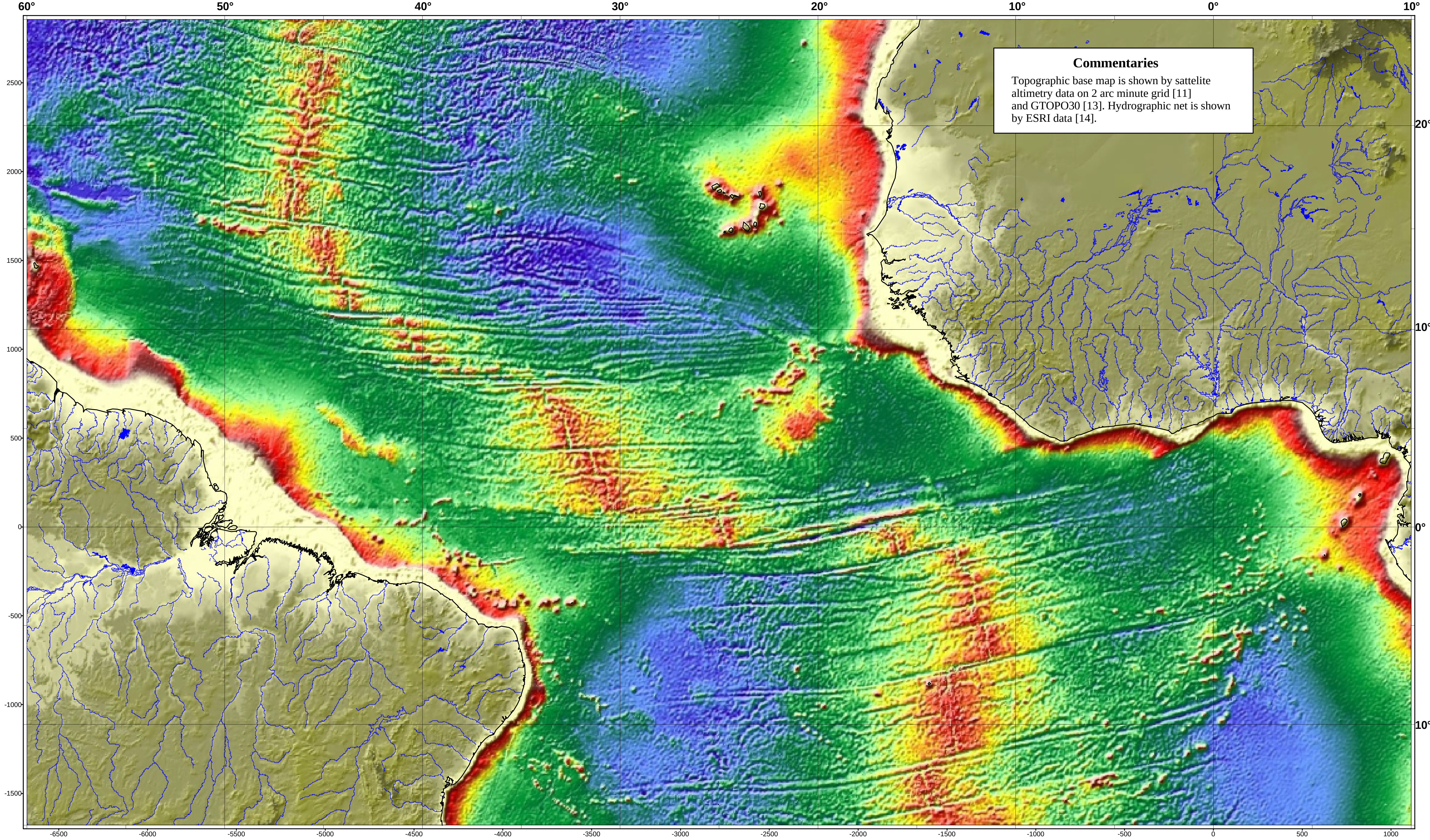
Depth and Elevation scale (meters)

-7000 -6000 -5000 -4000 -3000 -2000 -1000 0 1000 2000 3000

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Bottom Topography of Central Atlantic from Sattelite Altimetry Data and Topography of Adjacent Continents.

HARD NUT
Laboratory of Geomorphology
and Ocean Floor Tectonics
KREPKIY ORESHEK



List 3. 1998 *Sokolov S.Yu.*

km
0 200 400 600 800
Scale 1:20000000 by Equator

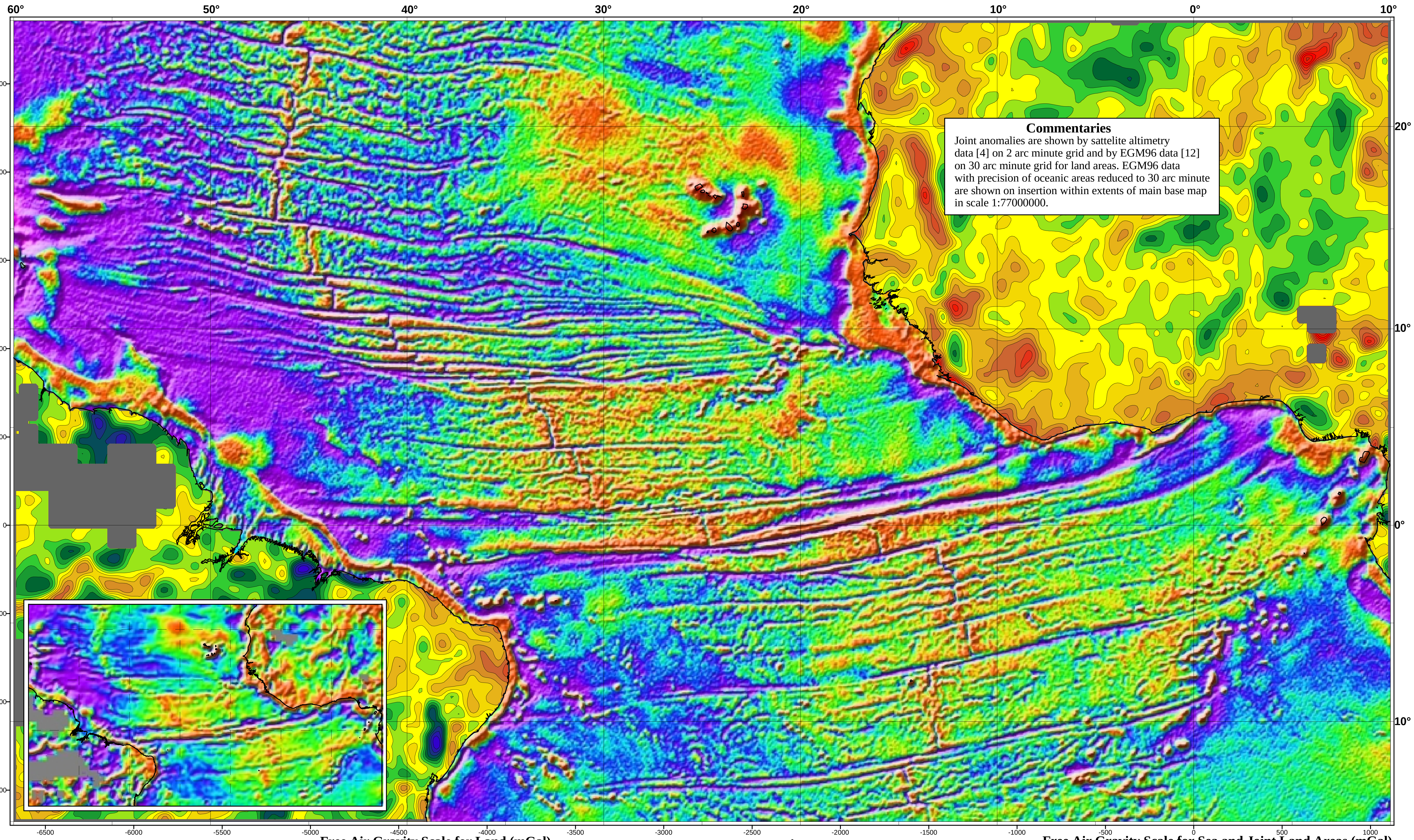
Depth and Elevation scale (meters)
-7000 -6000 -5000 -4000 -3000 -2000 -1000 0 1000 2000 3000

HARD NUT

Laboratory of Geomorphology and Ocean Floor Tectonics

KREPKIY ORESHEK

Joint Free Air Gravity Field Anomalies of Central Atlantic and Adjacent Continents



List 4.

Sokolov S.Yu.

1998

Free Air Gravity Scale for Land (mGal)

-80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110

km

0 200 400 600 800

Scale 1:20000000 by Equator

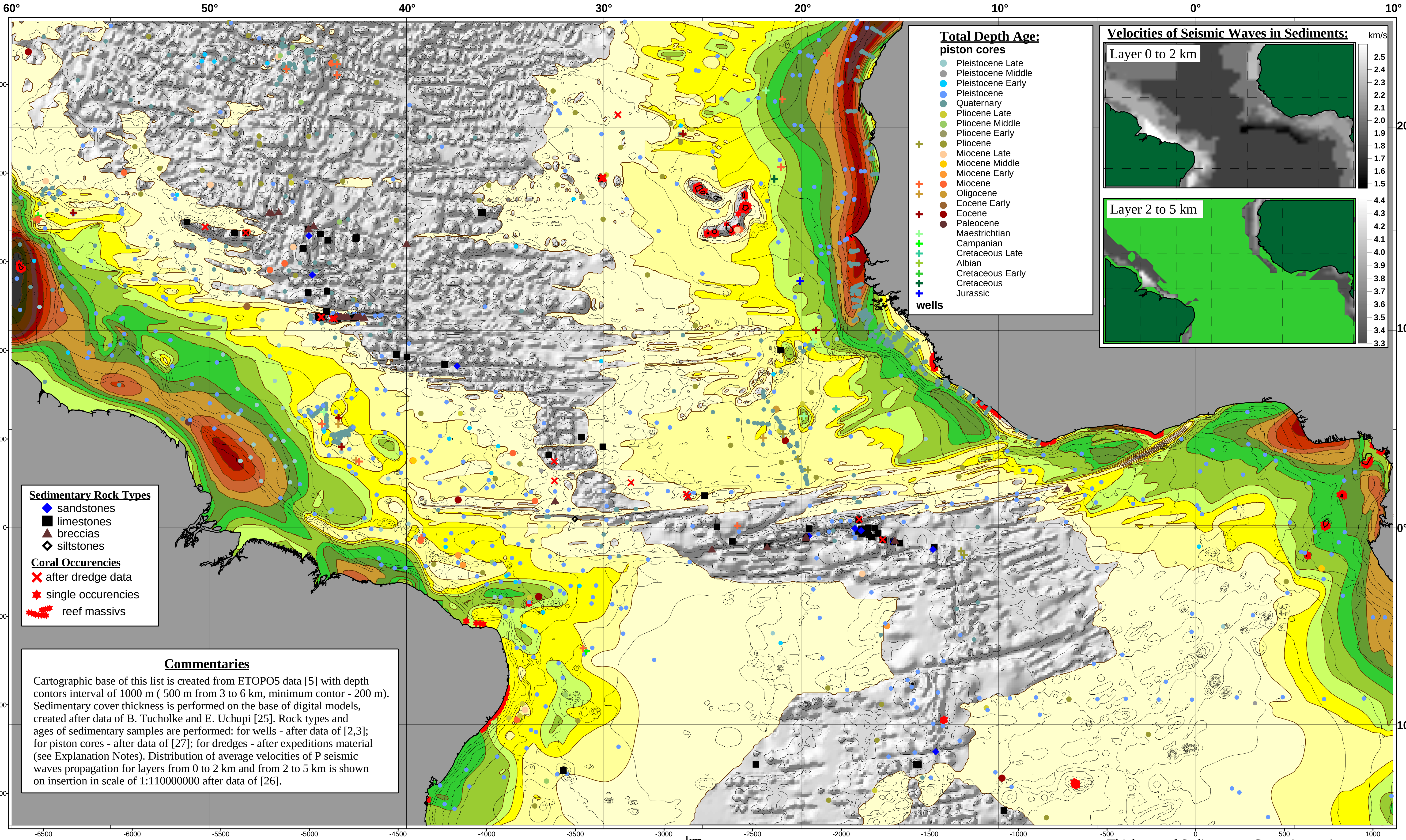
Free Air Gravity Scale for Sea and Joint Land Areas (mGal)

-250 -200 -150 -100 -50 0 50 100 150 200 250 300

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

The Structure of Sedimentary Cover of Central Atlantic.

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



List 5. 1999 *Sokolov S.Yu., Mazarovich A.O., Efimov V.N.*

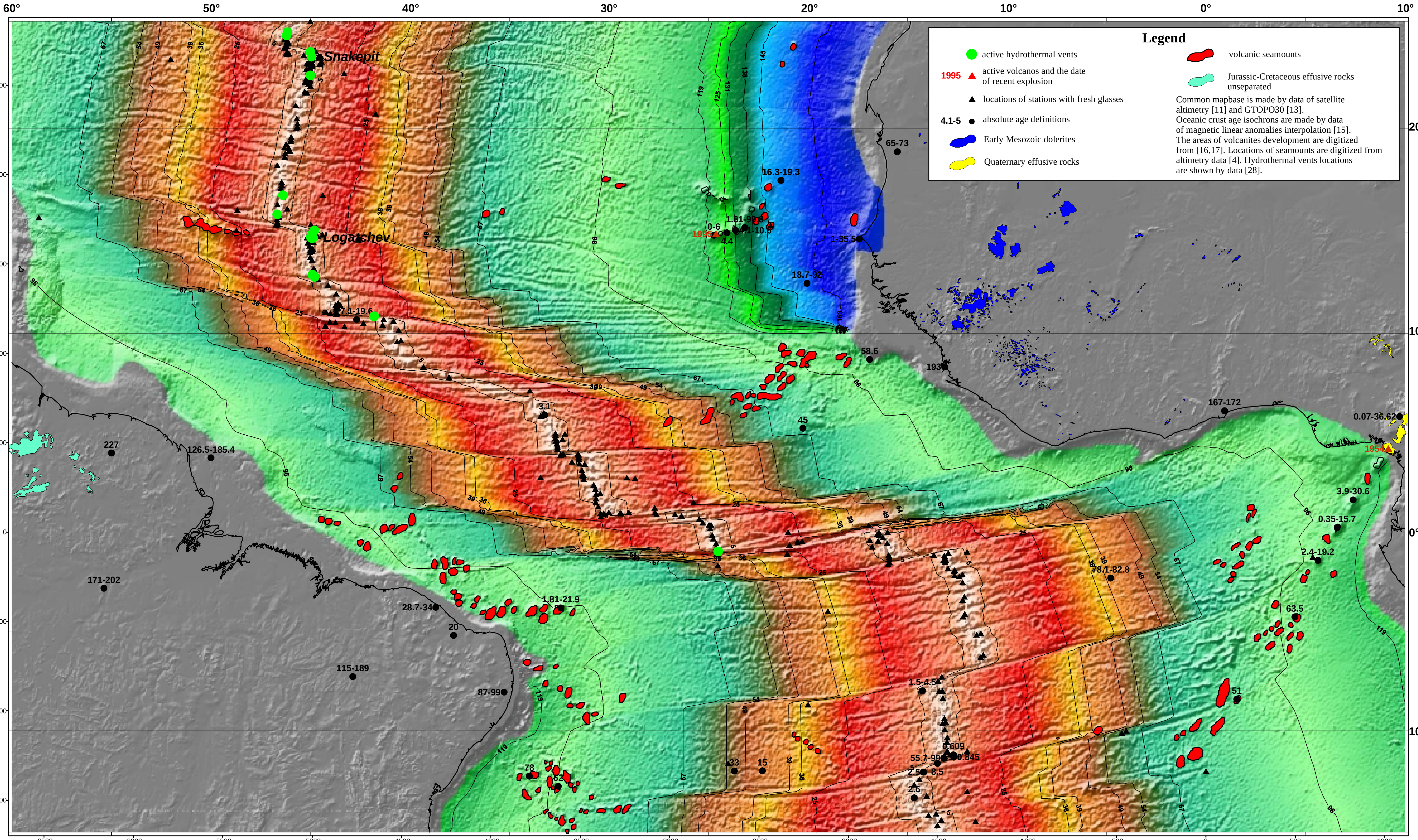
km
0 200 400 600 800
Scale 1:20000000 by Equator

Thickness of Sedimentary Cover (meters)

100 500 1000 1500 2000 3000 4000 5000 6000 8000 10000 12000 14000 16000 18000 20000

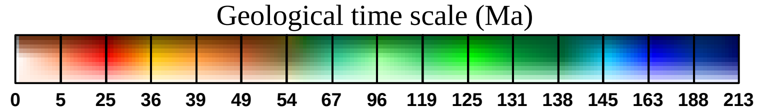
Mesozoic-Cenozoic Magmatism and Crust Age of Central Atlantic

Laboratory of Geomorphology and Ocean Floor Tectonics



km
0 200 400 600 800
Scale 1:20000000 by Equator

Geological time scale (Ma)

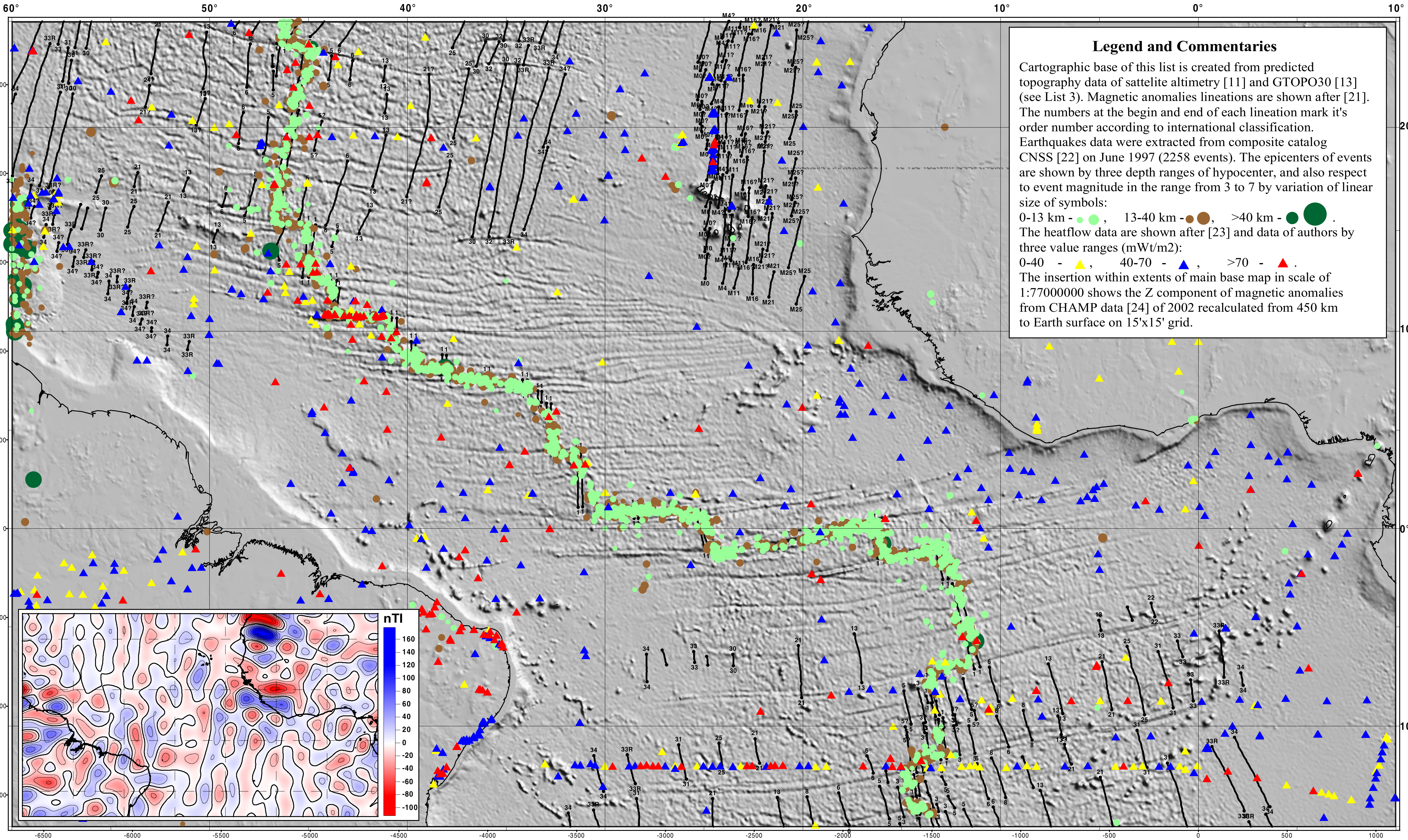


List 6. *Mazarovich A.O., Sokolov S.Yu., Dobrolyubova K.O.*

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Seismicity, Heatflow and Magnetic Anomalies of Central Atlantic.

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Legend and Commentaries

Cartographic base of this list is created from predicted topography data of sattelite altimetry [11] and GTOPO30 [13] (see List 3). Magnetic anomalies lineations are shown after [21]. The numbers at the begin and end of each lineation mark it's order number according to international classification. Earthquakes data were extracted from composite catalog CNSS [22] on June 1997 (2258 events). The epicenters of events are shown by three depth ranges of hypocenter, and also respect to event magnitude in the range from 3 to 7 by variation of linear size of symbols:

0-13 km - ● ●, 13-40 km - ● ●, >40 km - ● ●.

The heatflow data are shown after [23] and data of authors by three value ranges (mWt/m2):

0-40 - ▲, 40-70 - ▲, >70 - ▲.

The insertion within extents of main base map in scale of 1:77000000 shows the Z component of magnetic anomalies from CHAMP data [24] of 2002 recalculated from 450 km to Earth surface on 15'x15' grid.

km

0 200 400 600 800

Scale 1:20000000 by Equator

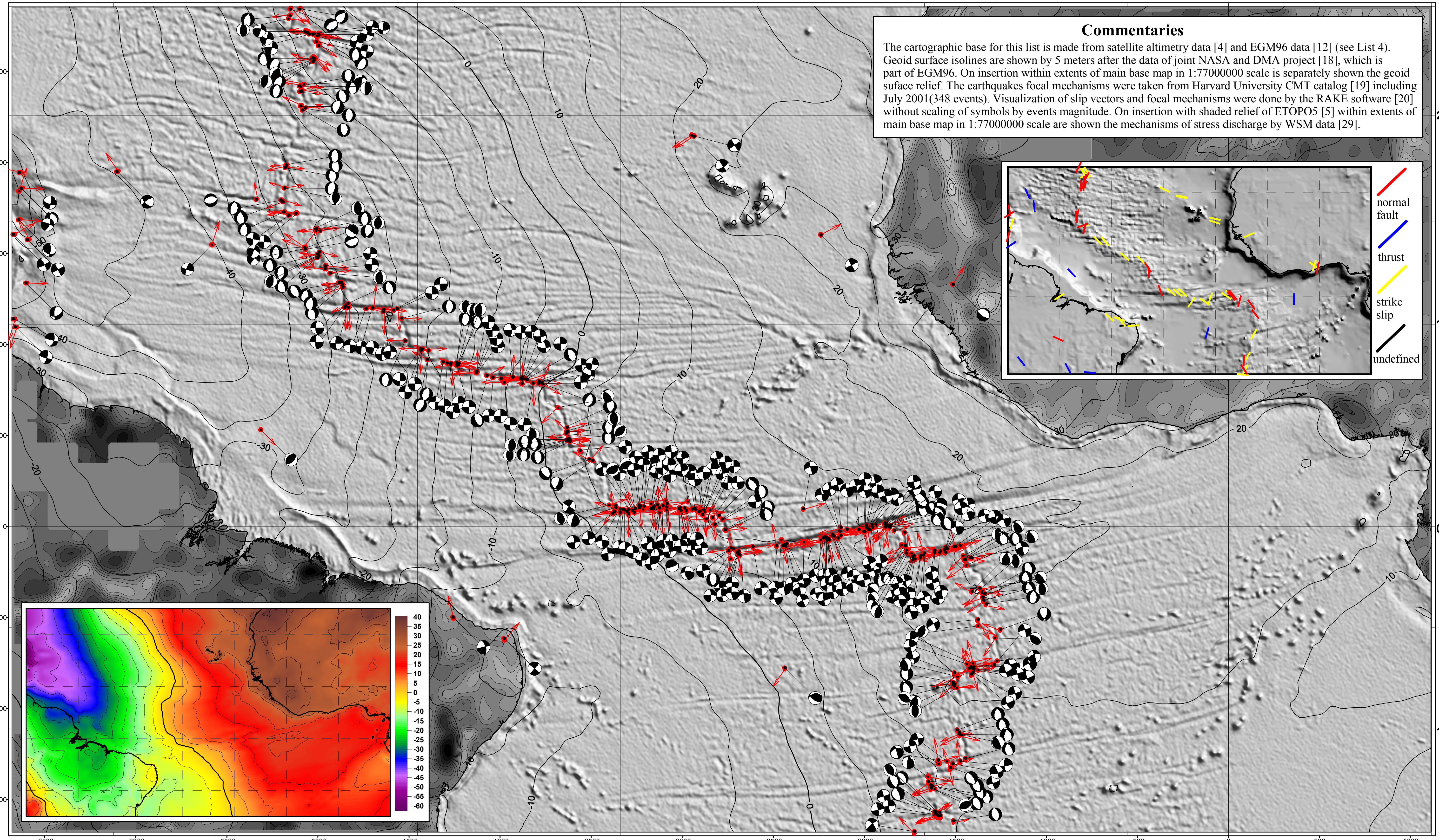
List 7.

Sokolov S.Yu., Podgornykh L.V. (VNIIOkeangeologiya), Khutorskoy M.D. (RUDN)

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Earthquakes Focal Mechanisms, Slip Vectors and Geoid Surface of Central Atlantic.

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Commentaries

The cartographic base for this list is made from satellite altimetry data [4] and EGM96 data [12] (see List 4). Geoid surface isolines are shown by 5 meters after the data of joint NASA and DMA project [18], which is part of EGM96. On insertion within extents of main base map in 1:77000000 scale is separately shown the geoid suface relief. The earthquakes focal mechanisms were taken from Harvard University CMT catalog [19] including July 2001(348 events). Visualization of slip vectors and focal mechanisms were done by the RAKE software [20] without scaling of symbols by events magnitude. On insertion with shaded relief of ETOPO5 [5] within extents of main base map in 1:77000000 scale are shown the mechanisms of stress discharge by WSM data [29].

km
0 200 400 600 800
Scale 1:20000000 by Equator

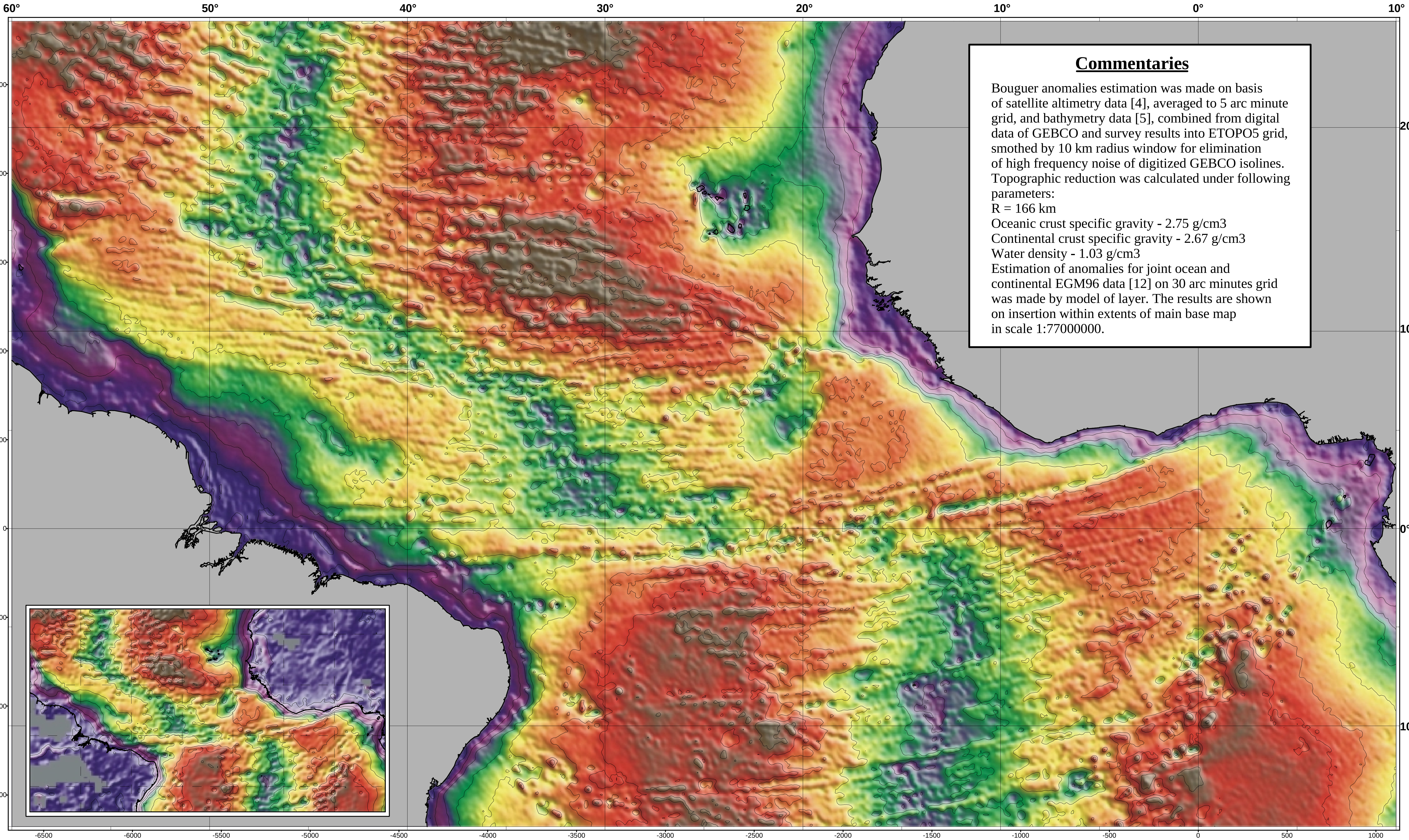
List 8.

 Sokolov S.Yu.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Bouguer Anomalies Calculated from Altymetry and Bathymetry Data on 5'x5' Grid.

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Commentaries

Bouguer anomalies estimation was made on basis of satellite altimetry data [4], averaged to 5 arc minute grid, and bathymetry data [5], combined from digital data of GEBCO and survey results into ETOPO5 grid, smothed by 10 km radius window for elimination of high frequency noise of digitized GEBCO isolines. Topographic reduction was calculated under following parameters:
R = 166 km
Oceanic crust specific gravity - 2.75 g/cm3
Continental crust specific gravity - 2.67 g/cm3
Water density - 1.03 g/cm3
Estimation of anomalies for joint ocean and continental EGM96 data [12] on 30 arc minutes grid was made by model of layer. The results are shown on insertion within extents of main base map in scale 1:77000000.

List 9. ©1999 *Sokolov S.Yu.*

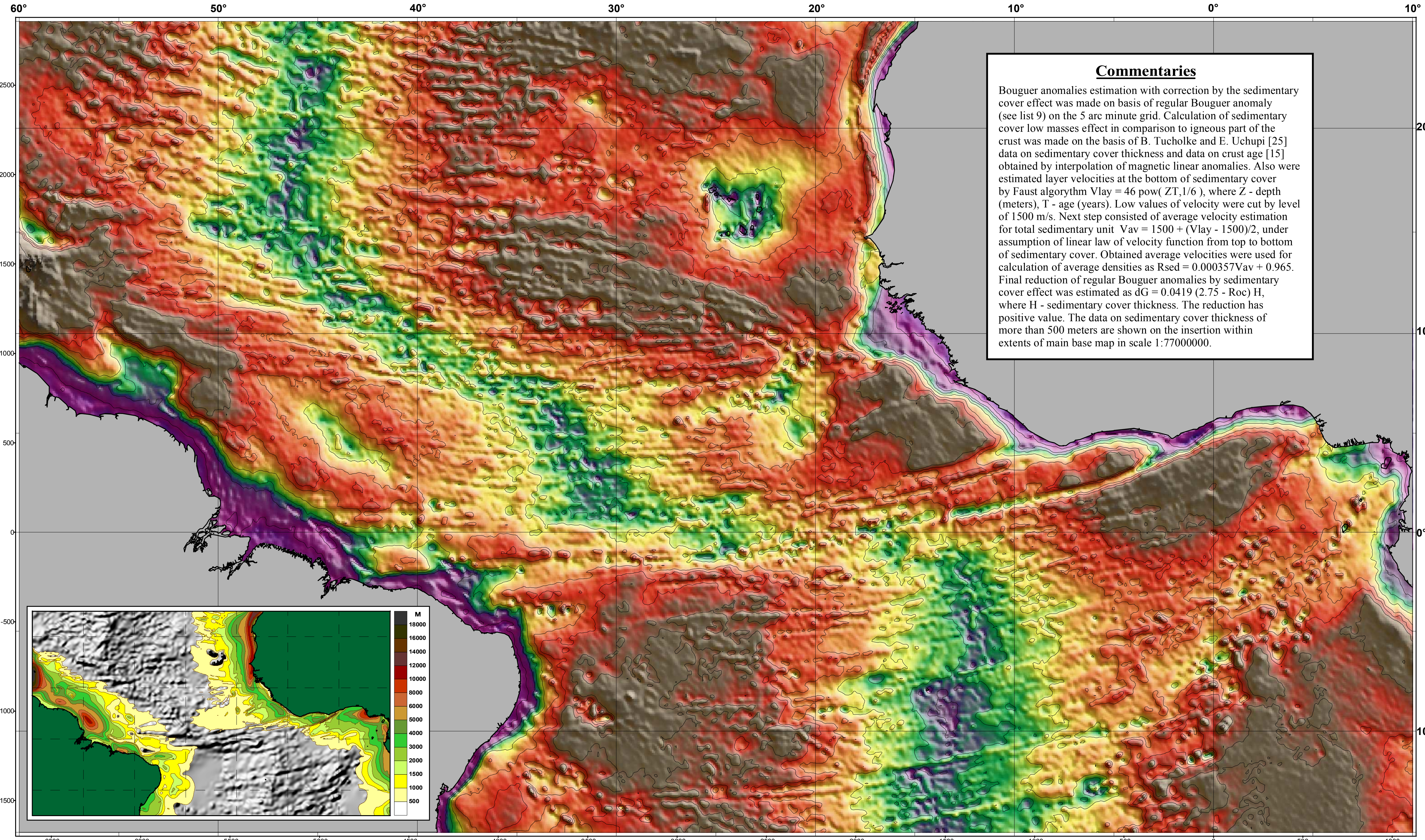
km
0 200 400 600 800
Scale 1:20000000 by Equator

Bouguer Anomalies Scale (mGal)
-200 -100 0 100 200 300 400 500 600

Bouguer Anomalies Calculated from Altymetry and Bathymetry Data on 5'x5' Grid with Correction by the Sedimentary Cover Effect.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Commentaries

Bouguer anomalies estimation with correction by the sedimentary cover effect was made on basis of regular Bouguer anomaly (see list 9) on the 5 arc minute grid. Calculation of sedimentary cover low masses effect in comparison to igneous part of the crust was made on the basis of B. Tucholke and E. Uchupi [25] data on sedimentary cover thickness and data on crust age [15] obtained by interpolation of magnetic linear anomalies. Also were estimated layer velocities at the bottom of sedimentary cover by Faust algorythm Vlay = 46 pow(ZT,1/6), where Z - depth (meters), T - age (years). Low values of velocity were cut by level of 1500 m/s. Next step consisted of average velocity estimation for total sedimentary unit Vav = 1500 + (Vlay - 1500)/2, under assumption of linear law of velocity function from top to bottom of sedimentary cover. Obtained average velocities were used for calculation of average densities as Rsed = 0.000357Vav + 0.965. Final reduction of regular Bouguer anomalies by sedimentary cover effect was estimated as dG = 0.0419 (2.75 - Roc) H, where H - sedimentary cover thickness. The reduction has positive value. The data on sedimentary cover thickness of more than 500 meters are shown on the insertion within extents of main base map in scale 1:77000000.

List 10. ©2003 *Sokolov S.Yu.*

km

0 200 400 600 800

Scale 1:20000000 by Equator

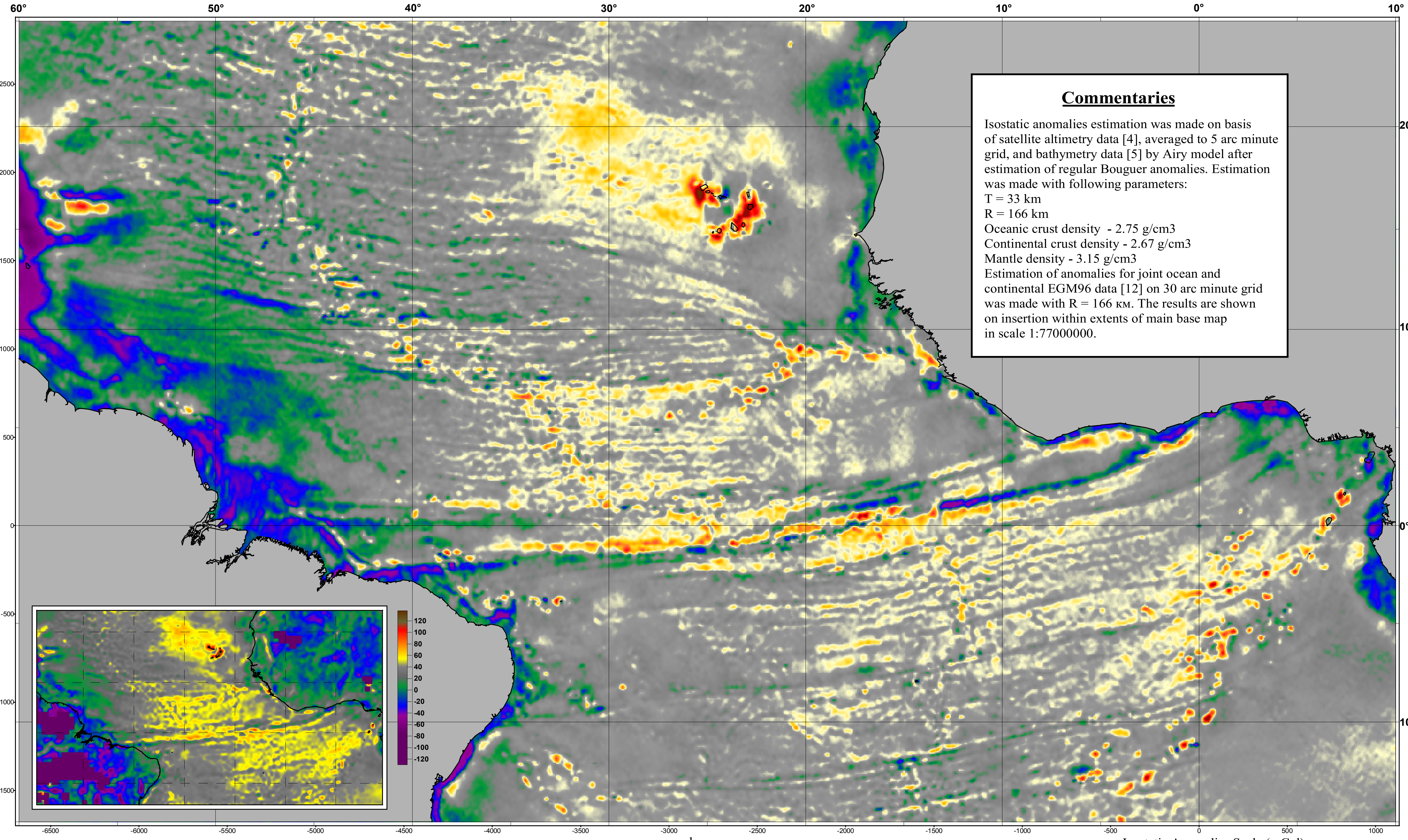
Bouguer Anomalies Scale (mGal)

-200 -100 0 100 200 300 400 500 600

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

Isostatic Anomalies Estimated from Altimetry and Bathymetry Data on 5'x5' grid by Airy model

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK

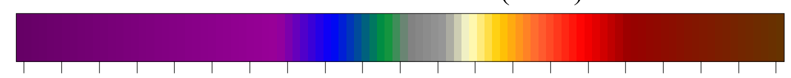


Commentaries

Isostatic anomalies estimation was made on basis of satellite altimetry data [4], averaged to 5 arc minute grid, and bathymetry data [5] by Airy model after estimation of regular Bouguer anomalies. Estimation was made with following parameters:
T = 33 km
R = 166 km
Oceanic crust density - 2.75 g/cm3
Continental crust density - 2.67 g/cm3
Mantle density - 3.15 g/cm3
Estimation of anomalies for joint ocean and continental EGM96 data [12] on 30 arc minute grid was made with R = 166 км. The results are shown on insertion within extents of main base map in scale 1:77000000.

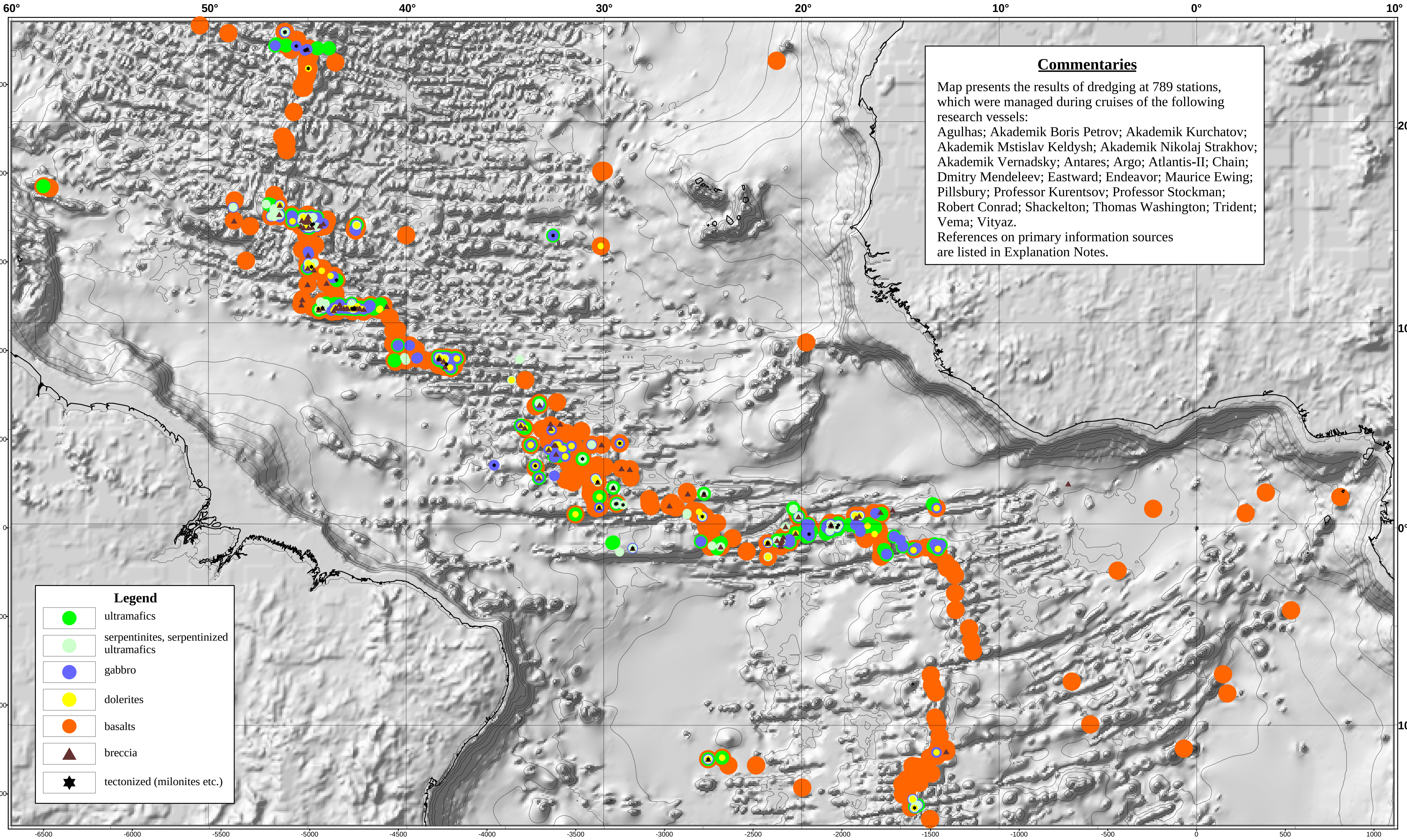
km
0 200 400 600 800
Scale 1:20000000 by Equator

Isostatic Anomalies Scale (mGal)



List 11. *Sokolov S.Yu.*

Basement Rocks of Central Atlantic from Dredge Stations.



List 12.

km

0 200 400 600 800

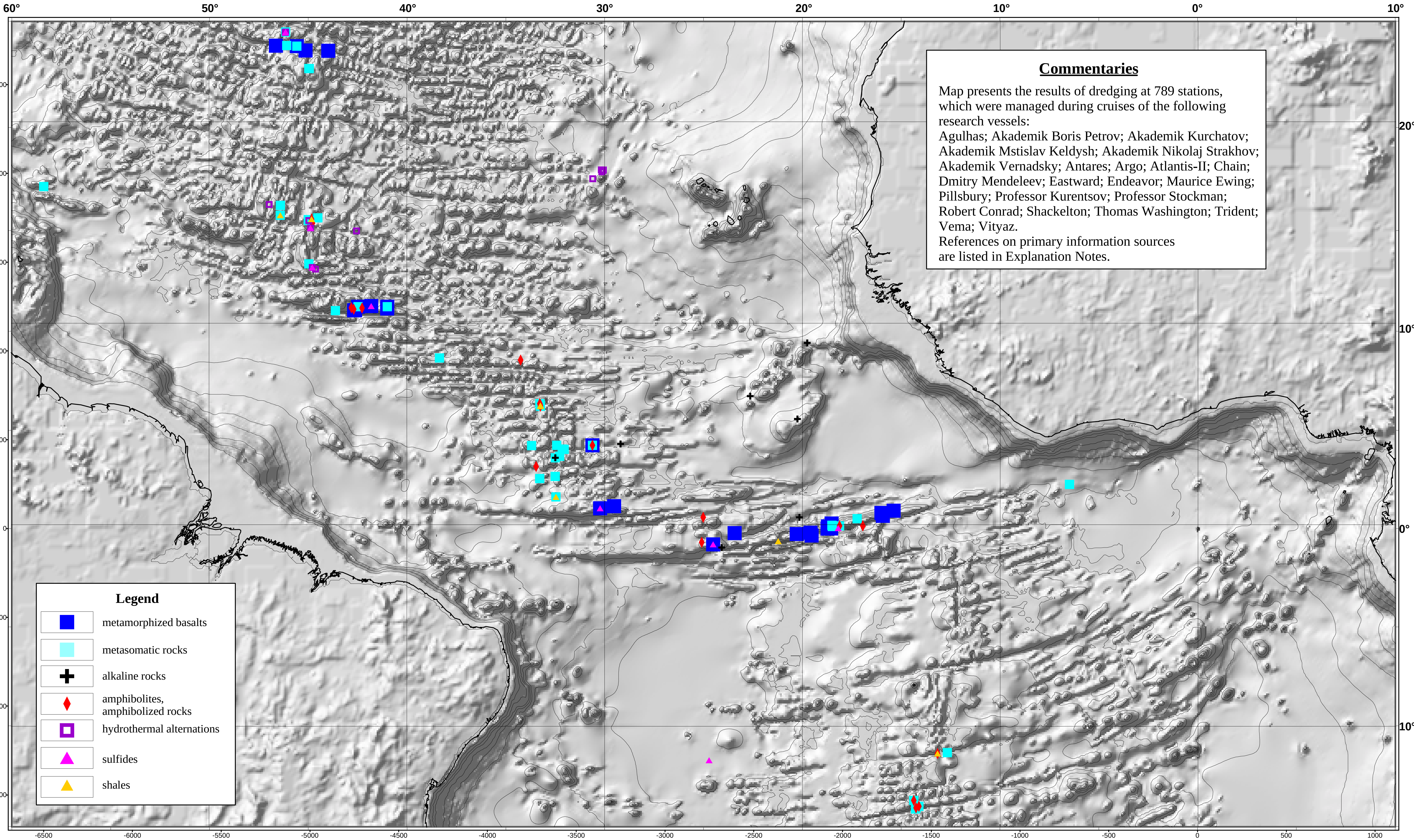
Scale 1:20000000 by Equator

1999 *Mazarovich A.O.*

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Alternations of Basement Rocks of Central Atlantic and Its Rare Types.

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



km
0 200 400 600 800
Scale 1:20000000 by Equator

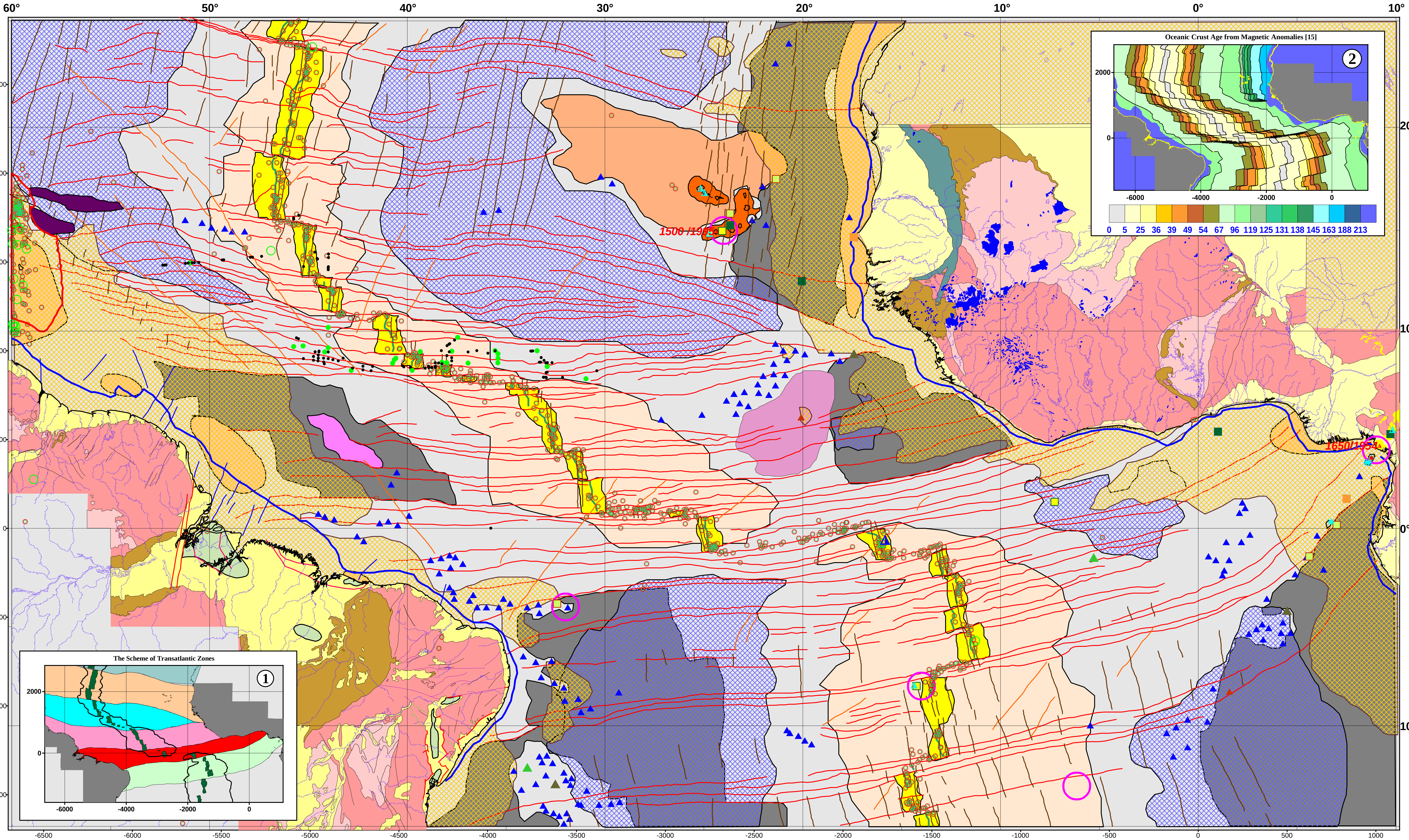
List 13.

1999 *Mazarovich A.O.*

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Tectonic Map of Central Atlantic.

HARD NUT
Laboratory of Geomorphology
and Ocean Floor Tectonics
KREPKIY ORESHEK



List 14.

km
0 200 400 600 800
Scale 1:20000000 by Equator

1999 *Mazarovich A.O., Dobrolyubova X.O.*

Legend to Tectonic Map of Central Atlantic

Laboratory of Geomorphology and Ocean Floor Tectonics

ОБЛАСТИ С КОРОЙ КОНТИНЕНТАЛЬНОГО ТИПА CONTINENTAL CRUST

- Фундамент платформ докембрийского возраста нерасчлененный / Precambrian Basement
- Докембрийские осадочные впадины / Precambrian Sedimentary Basins
- Палеозойский покровно-складчатый пояс ("мавританиды") / Paleozoic thrust-fold Belt ("mavritanide")
- Палеозойские осадочные впадины / Paleozoic Sedimentary Basins
- Мезозойские-кайнозойские осадочные впадины / Mesozoic-Cenozoic Sedimentary Basins
- Депоцентеры погружений фундамента (более 5000 м) / Depocenters of the Basement Subsidence (more 5000 m)
- Триас (?)-юрские субвулканические породы основного состава (преимущественно долериты) / Triassic (?)-Jurassic subvolcanic mafic rocks (mainly dolerites)

ОБЛАСТИ С КОРОЙ ОКЕАНИЧЕСКОГО ТИПА OCEANIC CRUST

- Районы со спокойным гравиметрическим полем / Smooth gravity field

Глубины Depth

- до 2500 м (соответствуют наиболее приподнятой части Срединно-Атлантического хребта) / shallower 2500 m (Uppermost part of the Mid-Atlantic Ridge)
- 2500-5000 м / 2500-5000 m
- более 5000 м / deeper 5000 m

Осадочный чехол с мощностью Sedimentary cover with thickness

- 1500-6000 м / 1500-6000 m
- более 6000 м / more than 6000 m

Области наложенных деформаций Secondary tectonized zones

- Поднятие Сьерра-Леоне / Sierra-Leone Rise
- Поднятие Сеара / Ceara Rise
- Поднятия Барракуда и Тибурон / Barracuda and Tiburon Ridges
- Структуры протыкания / Piercement srtuctures
- Складки в осадочном чехле / Folds in the sedimentary cover

МАГМАТИЗМ MAGMATISM

Вулканические постройки Volcanic edifices

С началом формирования: With start of activity in:

- Ранний мел / Early Cretacous
- Средний эоцен / Middle Eocenian
- Средний олигоцен, рупельский век / Middle Oligocenian, Rupelian
- Поздний миоцен / Late Miocenian
- Поздний плиоцен / Late Pliocenian

Зеленомысская провинция Cape-Verde Province

- Комплекс вулканических сооружений островов Зеленого Мыса / Complex of Cape Verde Volcanic edifices
- Предполагаемая область неогенового магматизма / Proposed area of Neogen magmatism

Стратовулканы: Stratovolcanous:

- голоценового возраста / of Holocene Age
- с историческими извержениями (первая цифра - дата наиболее раннего зафиксированного извержения, вторая - последнего) / with historical eruptions (first - data of the earlyest, second - last)

Щитовые вулканы: Shild volcanous:

- голоценового возраста / of Holocene Age
- с историческими извержениями / with historical eruptions

Подводные горы Seamounts

- кампанские / Campanian
- эоценовые / Eocenian
- олигоценовые / Oligocenian
- неизвестного возраста / Unknown Age
- с историческими извержениями / with historical eruptions

РАЗЛОМЫ FAULTS

Континентальная кора Continental crust

Докембрийские Precambrian

- Правые сдвиги / Right strike-slips
- Крутопадающие / Normal
- Надвиги / Thrusts

Мел-кайнозойские Cretaceous-Cenozoic

- Нерасчлененные в пределах суши / Unidentified on land
- Нерасчлененные в пределах шельфа / Unidentified o n shelf

Океаническая кора Oceanic crust

- Трансформные разломы / Transform Fracture Zones
- Прочие разломы / Others Fracture Zones
- Фронт деформации Барбадосской аккреционной призмы / Deformation front of Barbados accretionary prism

ПРОЧИЕ ЗНАКИ MISCELLANEOUS

- Оси магнитных аномалий / Axses of Magnetic Anomaleous

Эпицентры землетрясений Earthquakes Epicenters

- 0-13 km
- 13-40 km
- 40-500 km

- Положение горячих точек / Position of Hot spots (Muller, R.D., Royer, J.-Y., and Lawver, L.A., 1993, Revised plate motions relative to the hotspots from combined Atlantic and Indian Ocean hotspot tracks, Geology, vol. 21, pp. 275-278.)

УСЛОВНЫЕ ОБОЗНАЧЕНИЯ К ВРЕЗКЕ №1 LEGEND FOR INSERTION №1

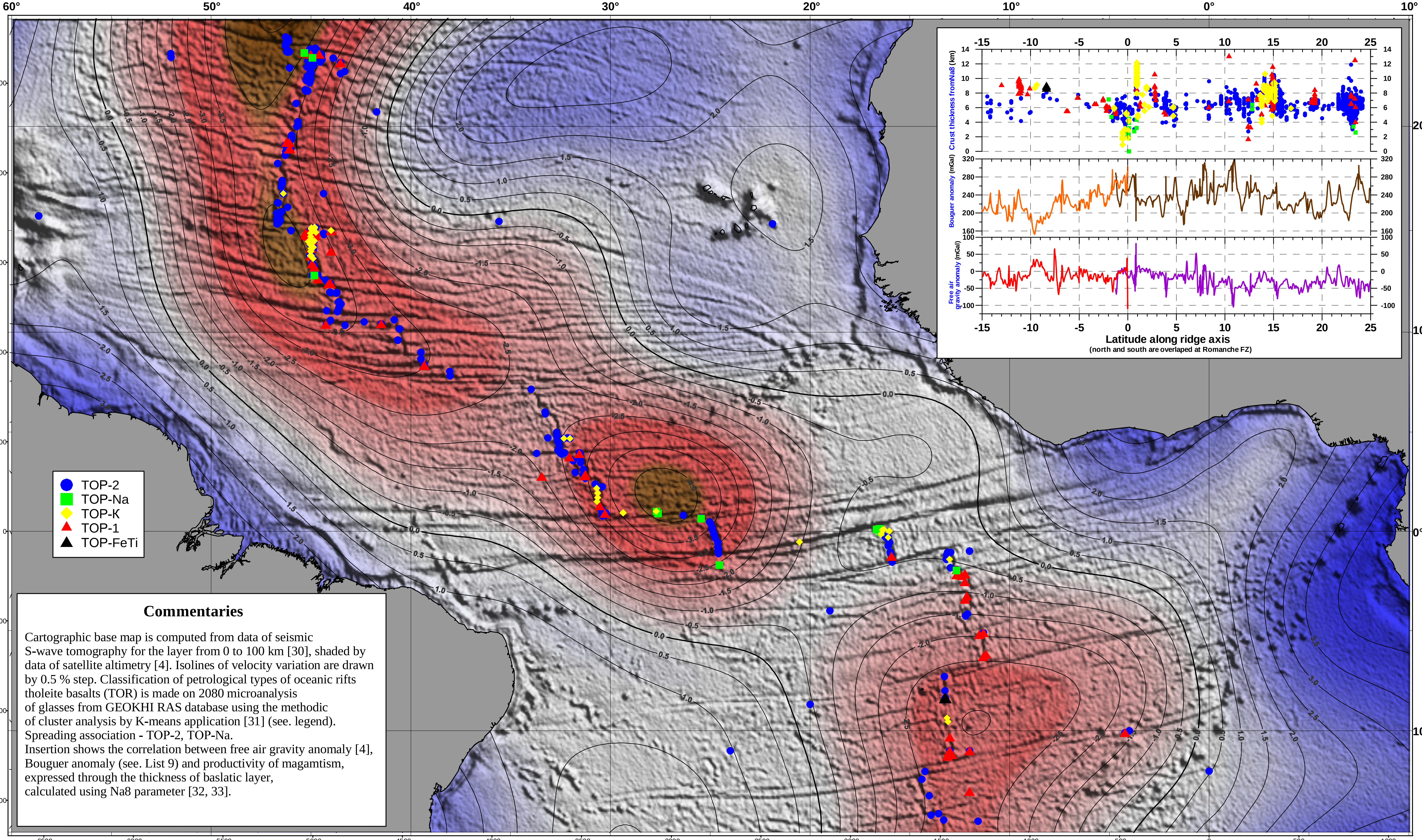
- Атлантис - Кейн / Atlantis - Kane
- Кейн - Зеленого Мыса / Kane - Cape Verde
- Зеленого Мыса - Сьерра-Леоне / Cape Verde - Sierra-Leone
- Сьерра-Леоне - Сан-Паулу / Sierra-Leone - San Paulu
- Сан-Паулу - Чейн / San Paulu - Chein
- Чейн - Кардно / Chein - Cardno
- Кардно / Cardno
- Рифтовая зона / Rift zone
- Наиболее приподнятая часть Срединно-Атлантического хребта / Upperst Part of Mid-Atlantic Ridge

1999 Mazarovich A.O.

Distribution of basic petrological types of oceanic rifts tholeite basalts (TOR), seismic S-wave tomography and thier correlation with free air gravity anomalies at the area of Central Atlantic Ocean

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Commentaries

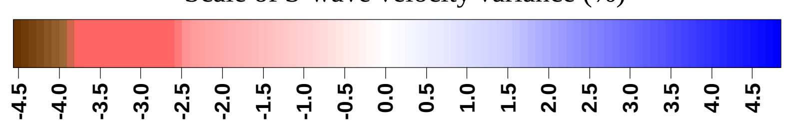
Cartographic base map is computed from data of seismic S-wave tomography for the layer from 0 to 100 km [30], shaded by data of satellite altimetry [4]. Isolines of velocity variation are drawn by 0.5 % step. Classification of petrological types of oceanic rifts tholeite basalts (TOR) is made on 2080 microanalysis of glasses from GEOKHI RAS database using the methodic of cluster analysis by K-means application [31] (see. legend). Spreading association - TOP-2, TOP-Na. Insertion shows the correlation between free air gravity anomaly [4], Bouguer anomaly (see. List 9) and productivity of magamtism, expressed through the thickness of baslatic layer, calculated using Na8 parameter [32, 33].

List 16.

Dmitriev L.V. (GEOKHI RAS), Sokolov S.Y., Plechova A.A. (GEOKHI RAS), Sokolov N.S. (MSU)

km
0 200 400 600 800
Scale 1:20000000 by Equator

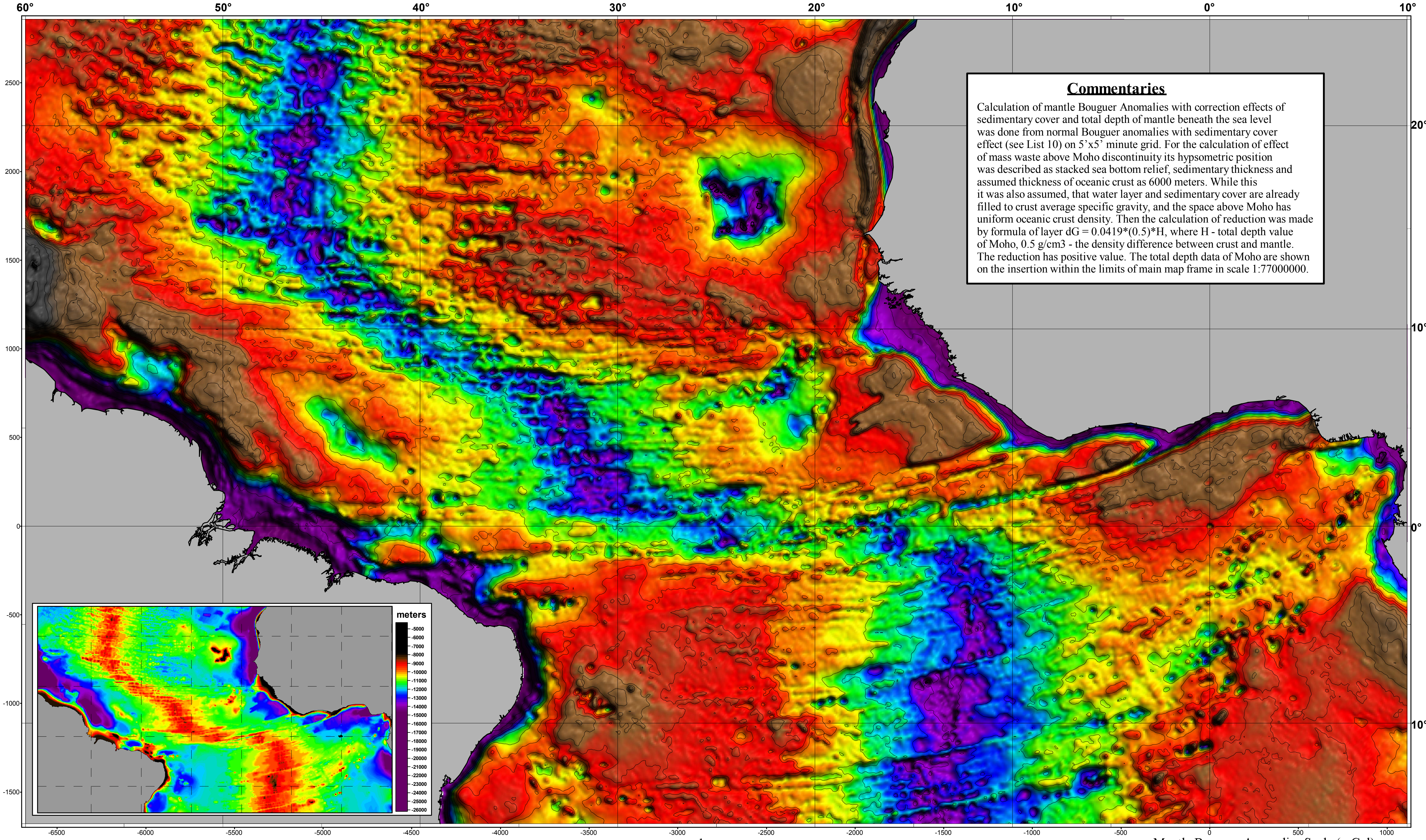
Scale of S-wave velocity variance (%)



HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Mantle Bouguer Anomalies Calculated from Altymetry and Bathymetry Data on 5'x5' Grid with Correction to Sedimentary Cover and Total Mantle Depth Effects.



Commentaries

Calculation of mantle Bouguer Anomalies with correction effects of sedimentary cover and total depth of mantle beneath the sea level was done from normal Bouguer anomalies with sedimentary cover effect (see List 10) on 5'x5' minute grid. For the calculation of effect of mass waste above Moho discontinuity its hypsometric position was described as stacked sea bottom relief, sedimentary thickness and assumed thickness of oceanic crust as 6000 meters. While this it was also assumed, that water layer and sedimentary cover are already filled to crust average specific gravity, and the space above Moho has uniform oceanic crust density. Then the calculation of reduction was made by formula of layer dG = 0.0419*(0.5)*H, where H - total depth value of Moho, 0.5 g/cm3 - the density difference between crust and mantle. The reduction has positive value. The total depth data of Moho are shown on the insertion within the limits of main map frame in scale 1:77000000.

List 17.

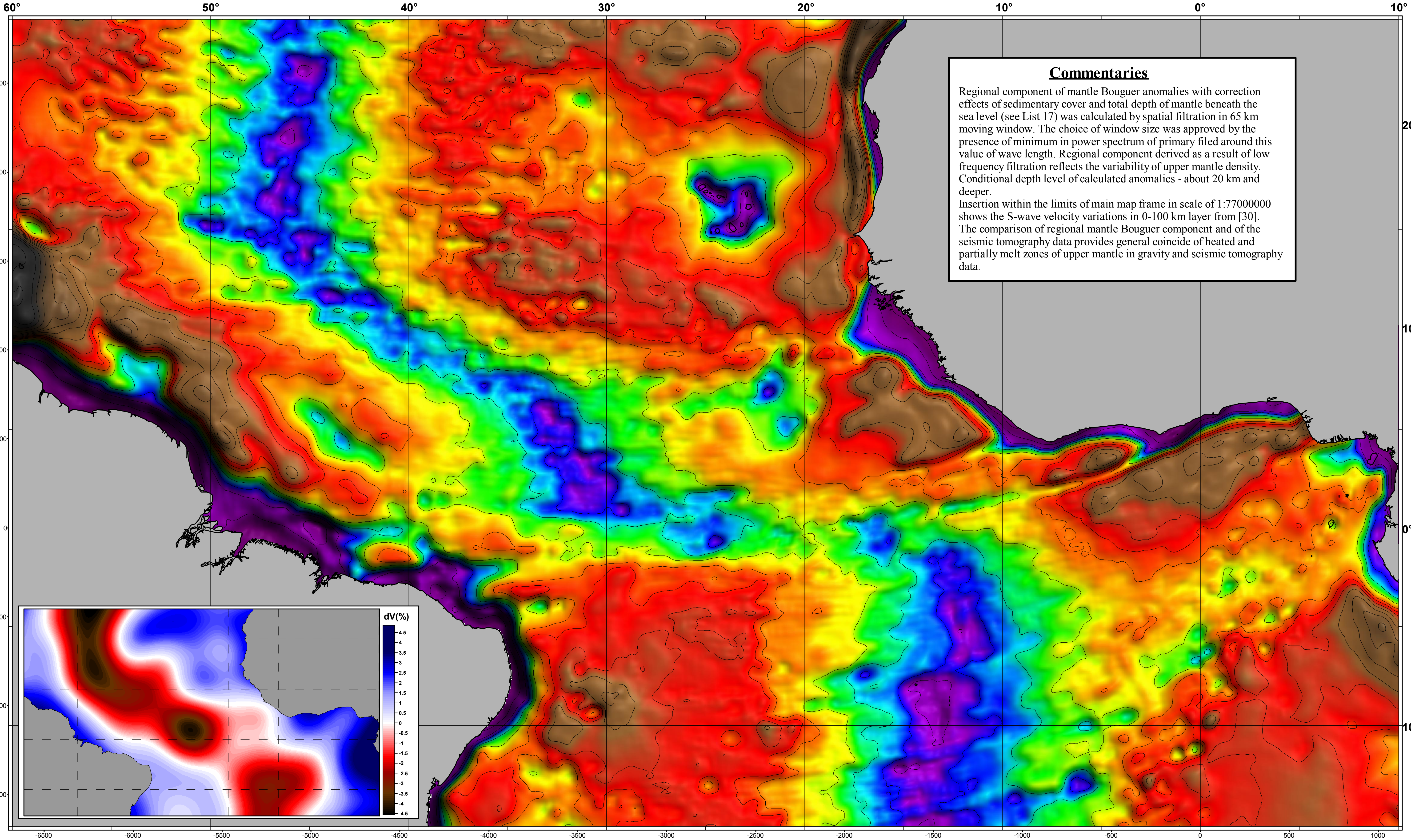
km
0 200 400 600 800
Scale 1:20000000 by Equator

Mantle Bouguer Anomalies Scale (mGal)
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

Regional Component of Mantle Bouguer Anomalies, Smoothed in 65 km Window.

HARD NUT
Laboratory of Geomorphology
and Ocean Floor Tectonics
KREPKIY ORESHEK



Commentaries

Regional component of mantle Bouguer anomalies with correction effects of sedimentary cover and total depth of mantle beneath the sea level (see List 17) was calculated by spatial filtration in 65 km moving window. The choice of window size was approved by the presence of minimum in power spectrum of primary filed around this value of wave length. Regional component derived as a result of low frequency filtration reflects the variability of upper mantle density. Conditional depth level of calculated anomalies - about 20 km and deeper.
Insertion within the limits of main map frame in scale of 1:77000000 shows the S-wave velocity variations in 0-100 km layer from [30].
The comparison of regional mantle Bouguer component and of the seismic tomography data provides general coincide of heated and partially melt zones of upper mantle in gravity and seismic tomography data.

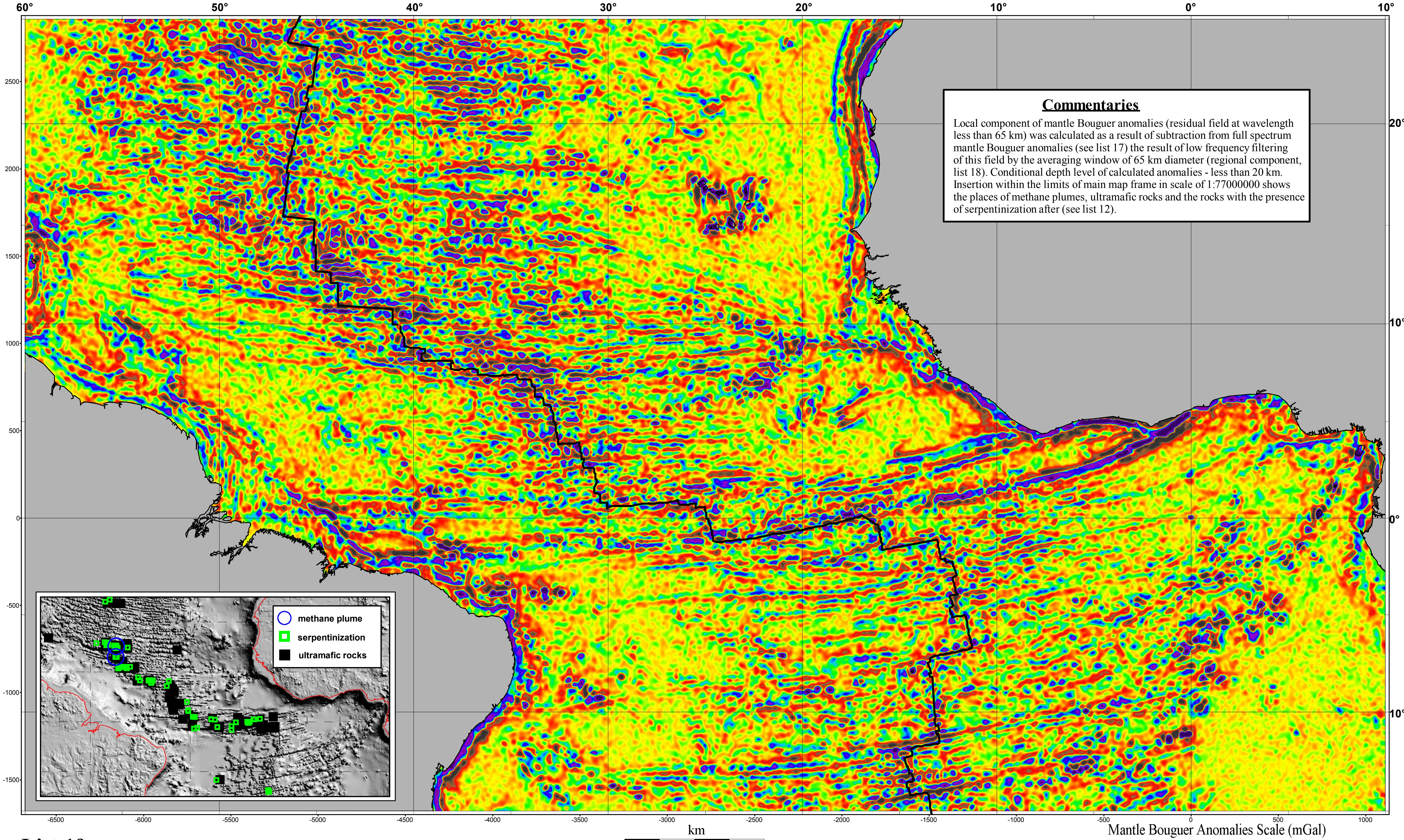
List 18.

km
0 200 400 600 800
Scale 1:20000000 by Equator

Mantle Bouguer Anomalies Scale (mGal)
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900 950 1000 1050 1100

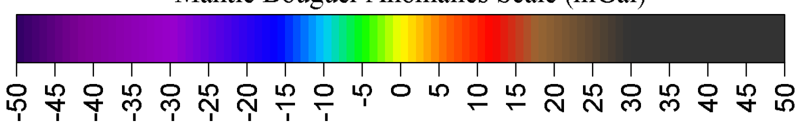
Local Component of Mantle Bouguer Anomalies (residual filed at wavelength less than 65 km).

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК
HARD NUT Laboratory of Geomorphology and Ocean Floor Tectonics KREPKIY ORESHEK



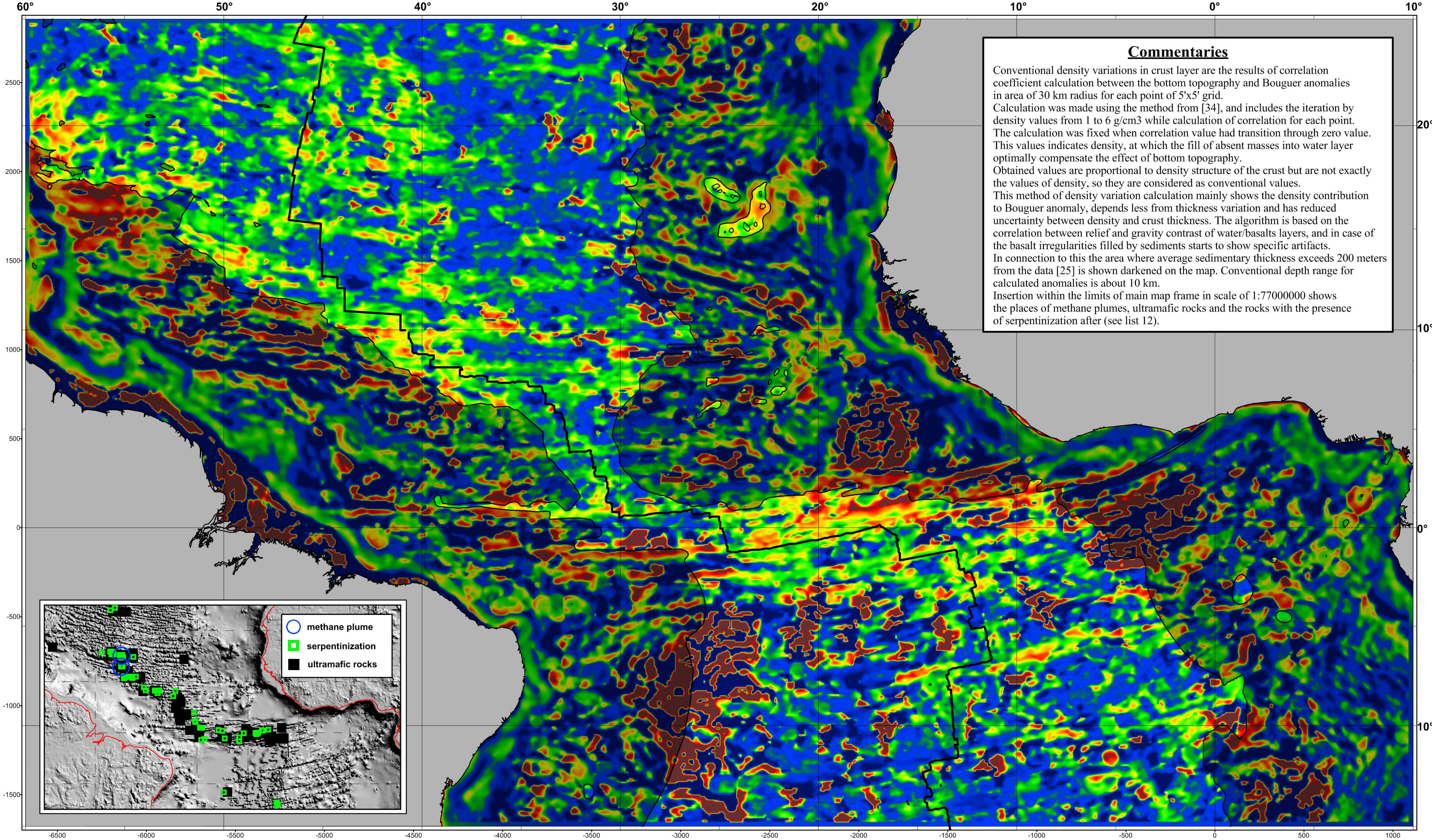
Commentaries

Local component of mantle Bouguer anomalies (residual field at wavelength less than 65 km) was calculated as a result of subtraction from full spectrum mantle Bouguer anomalies (see list 17) the result of low frequency filtering of this field by the averaging window of 65 km diameter (regional component, list 18). Conditional depth level of calculated anomalies - less than 20 km. Insertion within the limits of main map frame in scale of 1:77000000 shows the places of methane plumes, ultramafic rocks and the rocks with the presence of serpentinization after (see list 12).



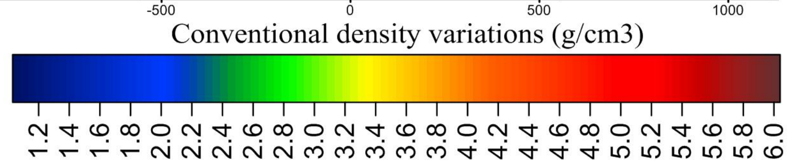
List 19. *Sokolov S.Yu., Mazarovich A.O.*

Conventional density variations in crust layer.



Commentaries

Conventional density variations in crust layer are the results of correlation coefficient calculation between the bottom topography and Bouguer anomalies in area of 30 km radius for each point of 5'x5' grid.
Calculation was made using the method from [34], and includes the iteration by density values from 1 to 6 g/cm3 while calculation of correlation for each point.
The calculation was fixed when correlation value had transition through zero value.
This values indicates density, at which the fill of absent masses into water layer optimally compensate the effect of bottom topography.
Obtained values are proportional to density structure of the crust but are not exactly the values of density, so they are considered as conventional values.
This method of density variation calculation mainly shows the density contribution to Bouguer anomaly, depends less from thickness variation and has reduced uncertainty between density and crust thickness. The algorithm is based on the correlation between relief and gravity contrast of water/basalts layers, and in case of the basalt irregularities filled by sediments starts to show specific artifacts.
In connection to this the area where average sedimentary thickness exceeds 200 meters from the data [25] is shown darkened on the map. Conventional depth range for calculated anomalies is about 10 km.
Insertion within the limits of main map frame in scale of 1:77000000 shows the places of methane plumes, ultramafic rocks and the rocks with the presence of serpentinization after (see list 12).



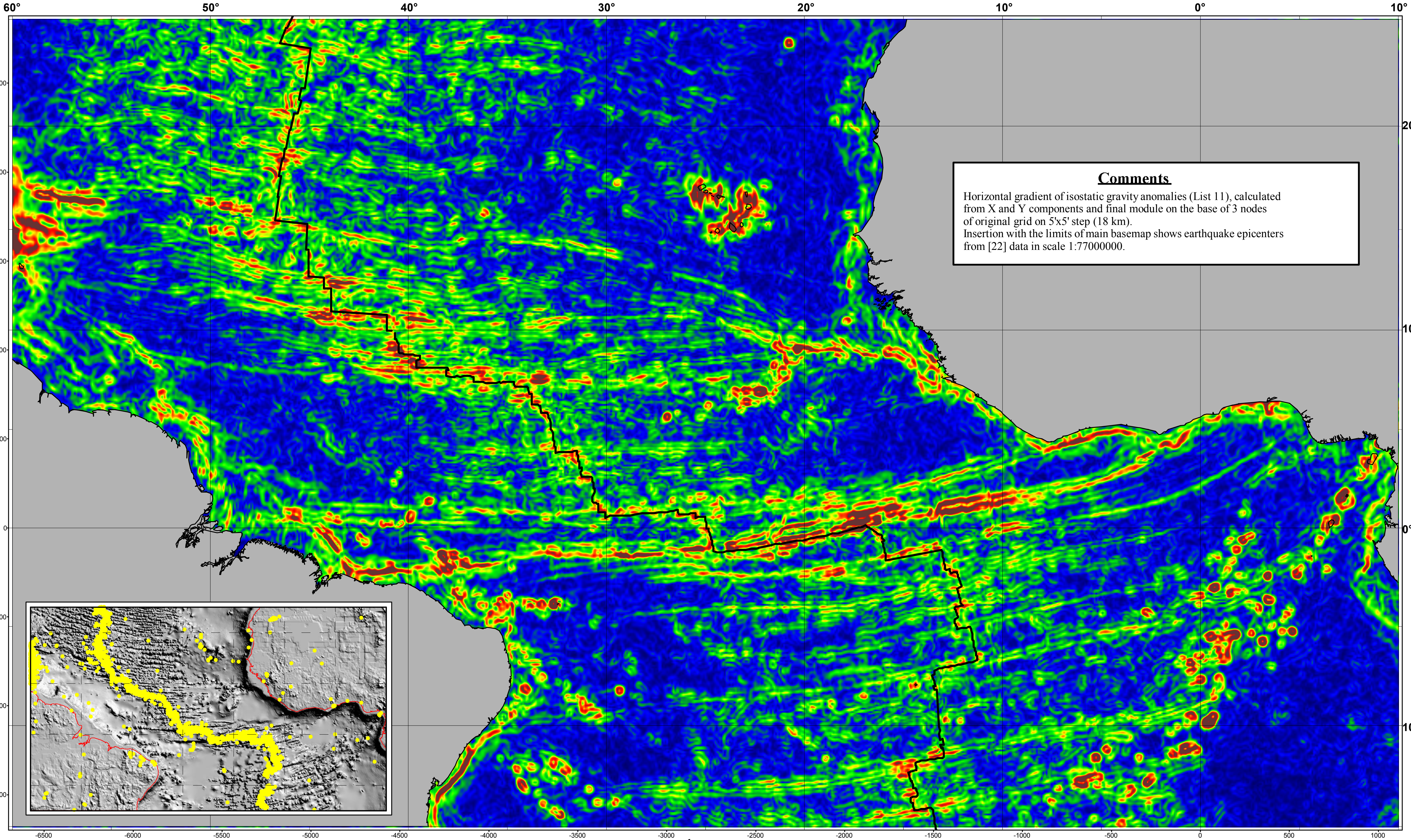
List 20.

 Sokolov S.Yu., Mazarovich A.O.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

HARD NUT
Laboratory of Geomorphology
and Ocean Floor Tectonics
KREPKIY ORESHEK

Horizontal gradient of gravity isostatic anomalies



Comments

Horizontal gradient of isostatic gravity anomalies (List 11), calculated from X and Y components and final module on the base of 3 nodes of original grid on 5'x5' step (18 km).
Insertion with the limits of main basemap shows earthquake epicenters from [22] data in scale 1:77000000.

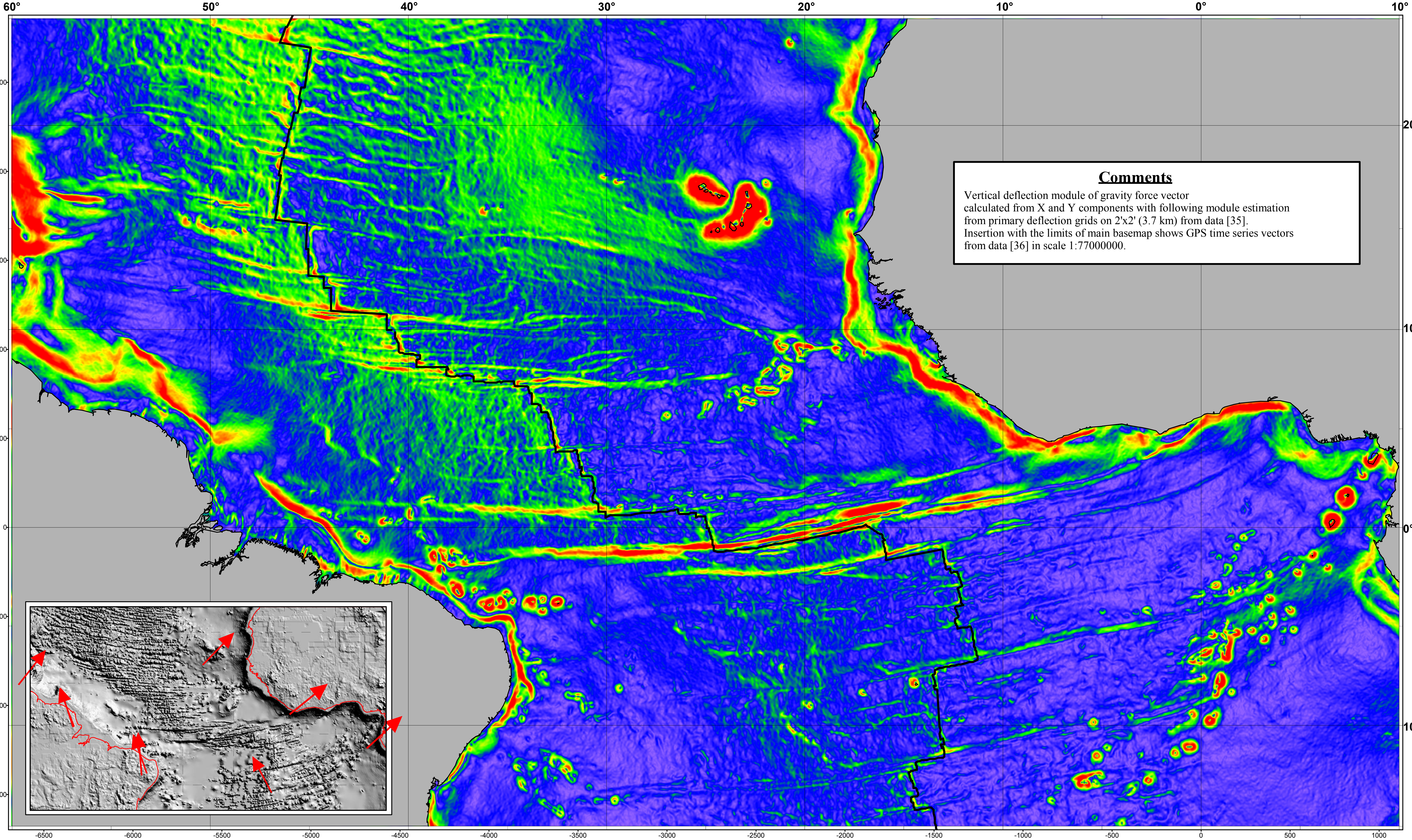
km
0 200 400 600 800
Scale 1:20000000 by Equator

Scale of horizontal isostasy gradient (mGal/km)
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160

List 21.

Laboratory of Geomorphology and Ocean Floor Tectonics

Vertical Defletion Module of Gravity Force Vector



Comments

Vertical deflection module of gravity force vector calculated from X and Y components with following module estimation from primary deflection grids on 2'x2' (3.7 km) from data [35]. Insertion with the limits of main basemap shows GPS time series vectors from data [36] in scale 1:77000000.

List 22. *Sokolov S.Yu.*

km

0 200 400 600 800

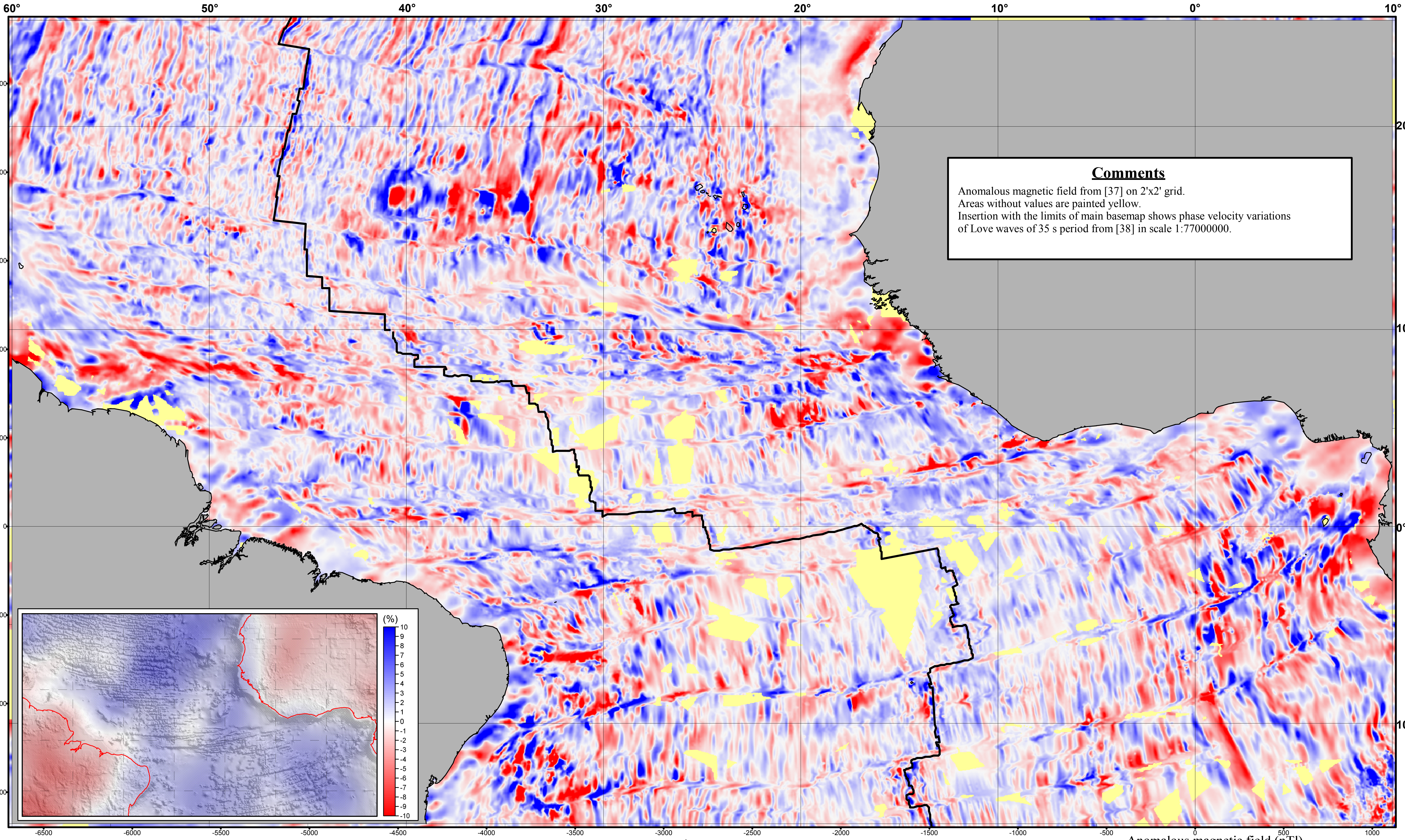
Scale 1:20000000 by Equator

Vertical Deflection Module (microradians)

5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85

Anomalous Magnetic Field

Laboratory of Geomorphology and Ocean Floor Tectonics



Comments

Anomalous magnetic field from [37] on 2'x2' grid.
Areas without values are painted yellow.
Insertion with the limits of main basemap shows phase velocity variations of Love waves of 35 s period from [38] in scale 1:77000000.

km
0 200 400 600 800
Scale 1:20000000 by Equator

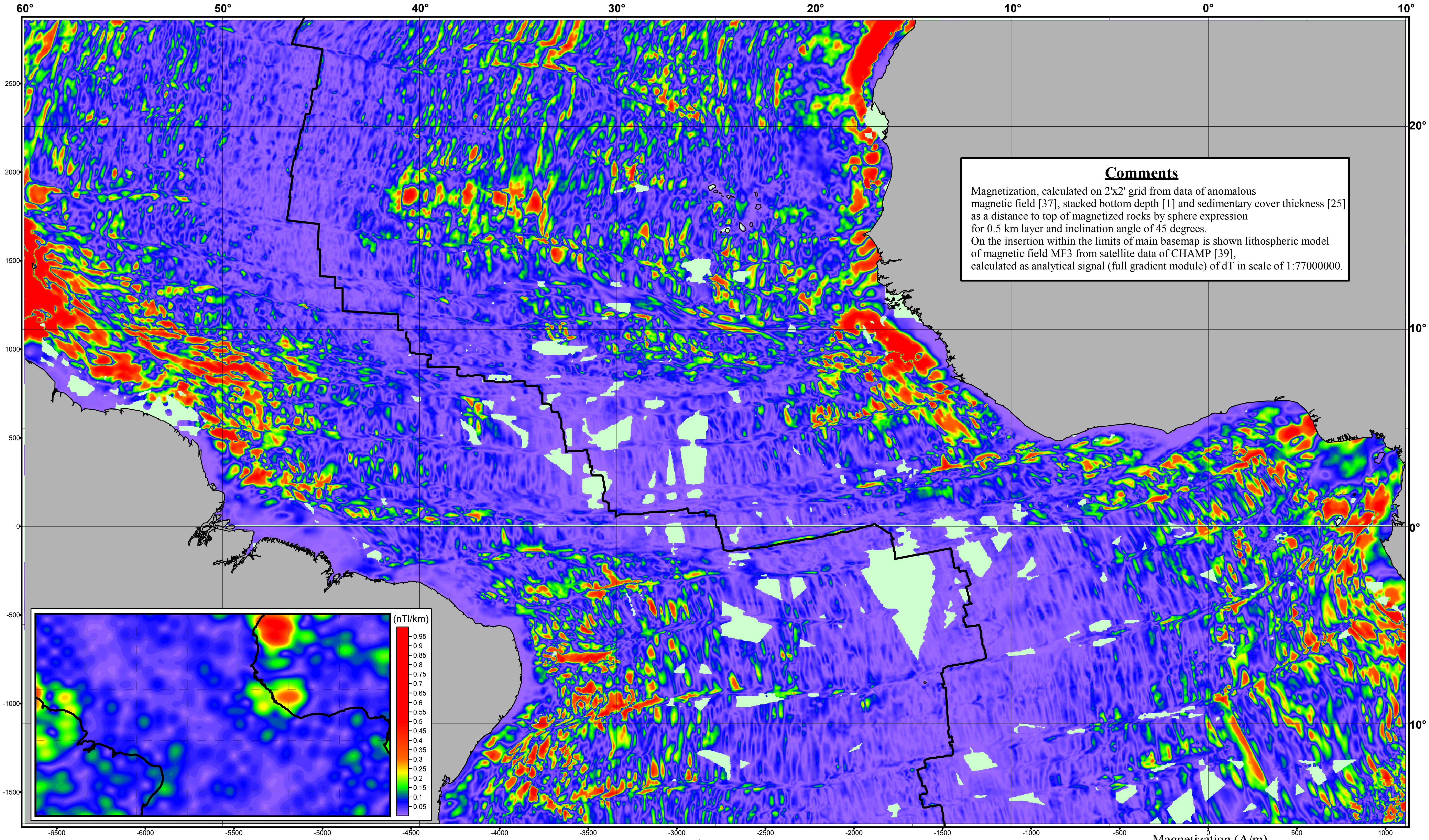
Anomalous magnetic field (nTl)
-130 -120 -110 -100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110 120 130

List 23.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

Laboratory of Geomorphology and Ocean Floor Tectonics

Magnetization



Comments

Magnetization, calculated on 2'x2' grid from data of anomalous magnetic field [37], stacked bottom depth [1] and sedimentary cover thickness [25] as a distance to top of magnetized rocks by sphere expression for 0.5 km layer and inclination angle of 45 degrees.
On the insertion within the limits of main basemap is shown lithospheric model of magnetic field MF3 from satellite data of CHAMP [39], calculated as analytical signal (full gradient module) of dT in scale of 1:77000000.

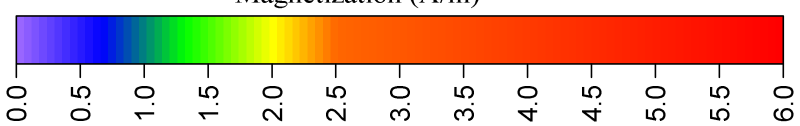
List 24. *Sokolov S.Yu.*

km

0 200 400 600 800

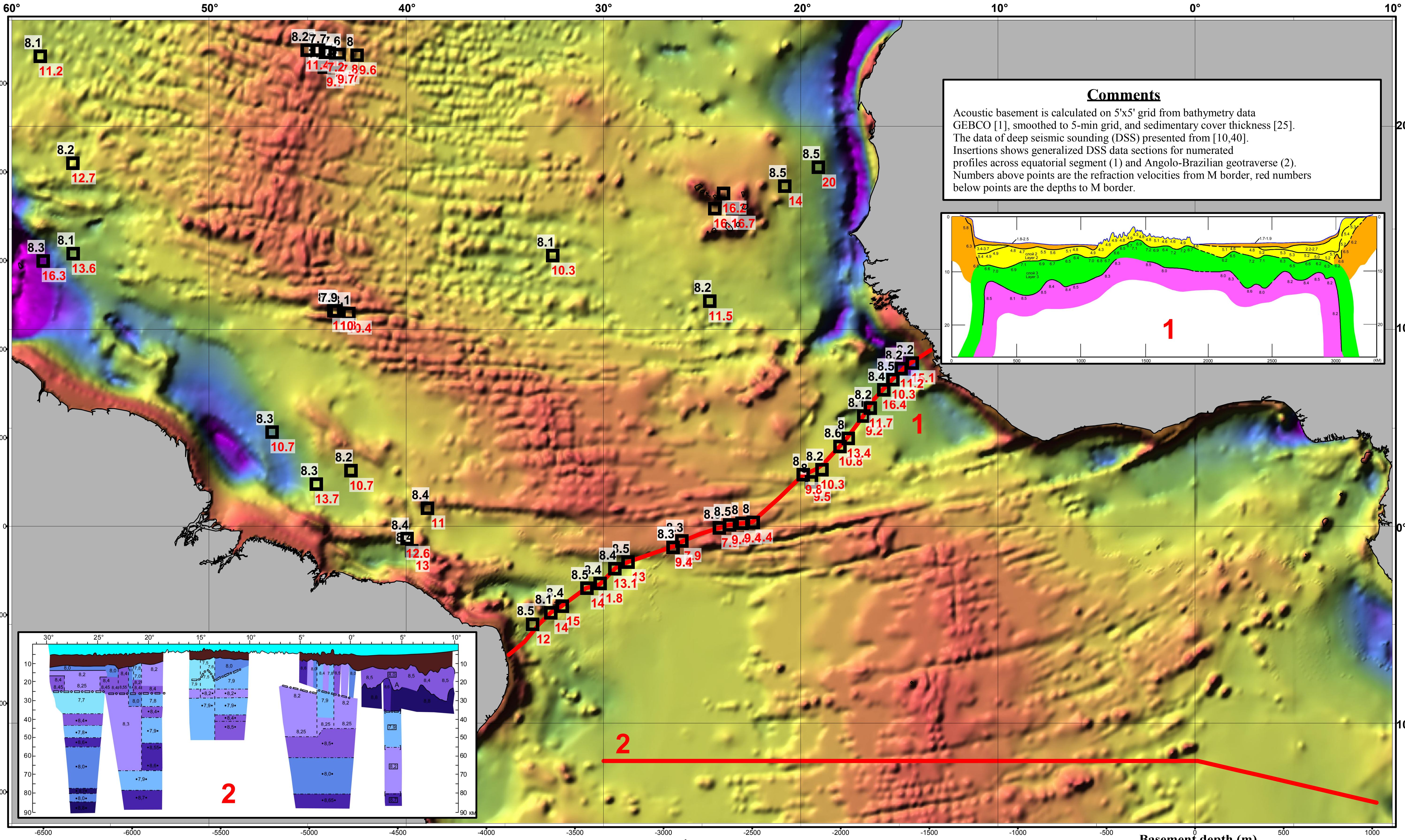
Scale 1:20000000 by Equator

Magnetization (A/m)



Laboratory of Geomorphology and Ocean Floor Tectonics

Acoustic Basement and Deep Seismic Sounding Data



Comments

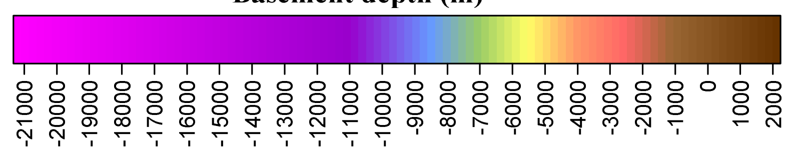
Acoustic basement is calculated on 5'x5' grid from bathymetry data GEBCO [1], smoothed to 5-min grid, and sedimentary cover thickness [25]. The data of deep seismic sounding (DSS) presented from [10,40]. Insertions shows generalized DSS data sections for numerated profiles across equatorial segment (1) and Angolo-Brazilian geotraverse (2). Numbers above points are the refraction velocities from M border, red numbers below points are the depths to M border.

km

0 200 400 600 800

Scale 1:20000000 by Equator

Basement depth (m)

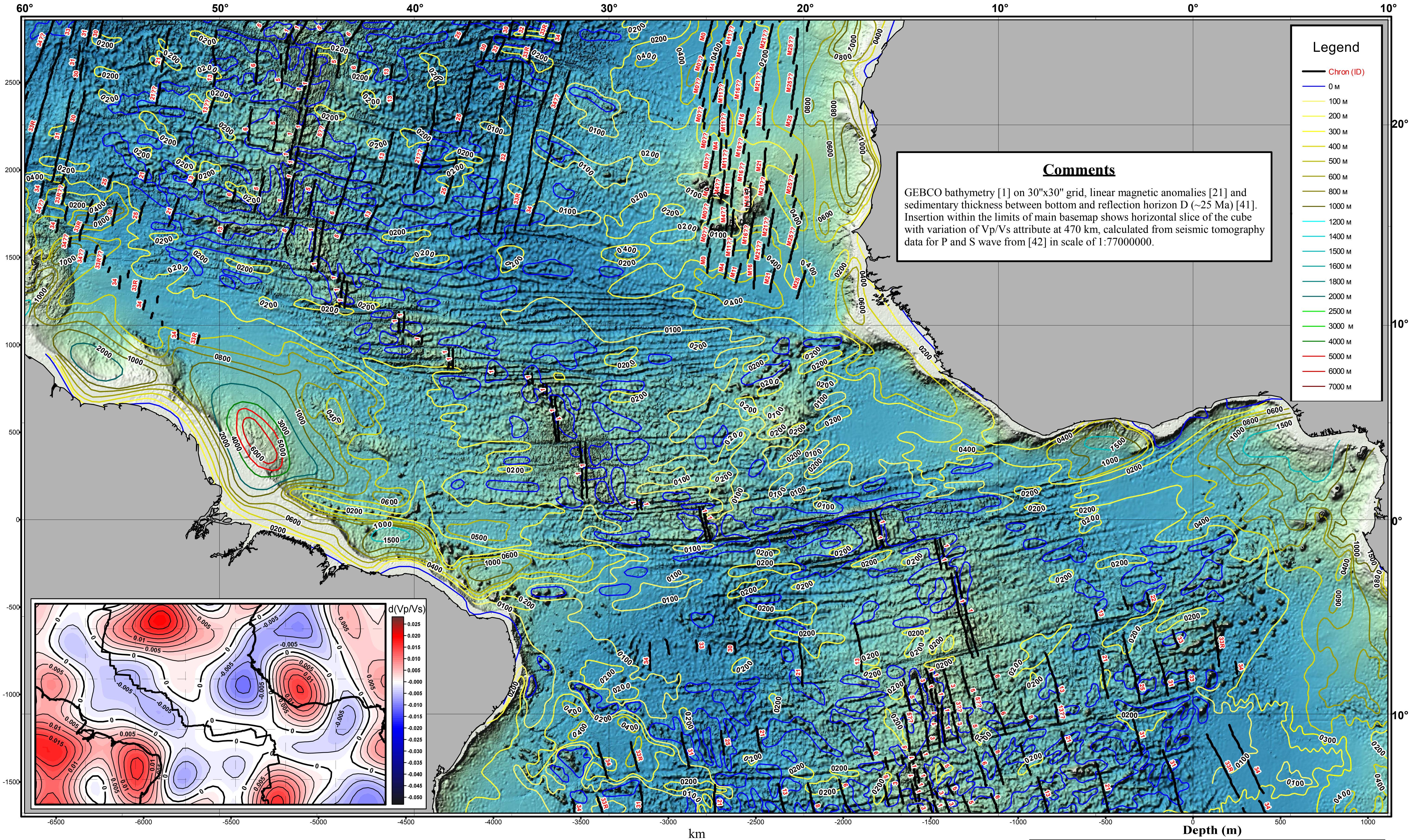


List 25.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Thickness of sediments between bottom and reflection horizon D (~25 Ma) and linear magnetic anomalies

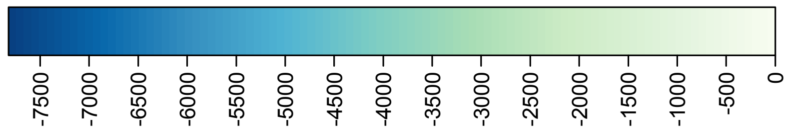
HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Comments

GEBCO bathymetry [1] on 30"x30" grid, linear magnetic anomalies [21] and sedimentary thickness between bottom and reflection horizon D (~25 Ma) [41]. Insertion within the limits of main basemap shows horizontal slice of the cube with variation of Vp/Vs attribute at 470 km, calculated from seismic tomography data for P and S wave from [42] in scale of 1:77000000.

km
0 200 400 600 800
Scale 1:20000000 by Equator

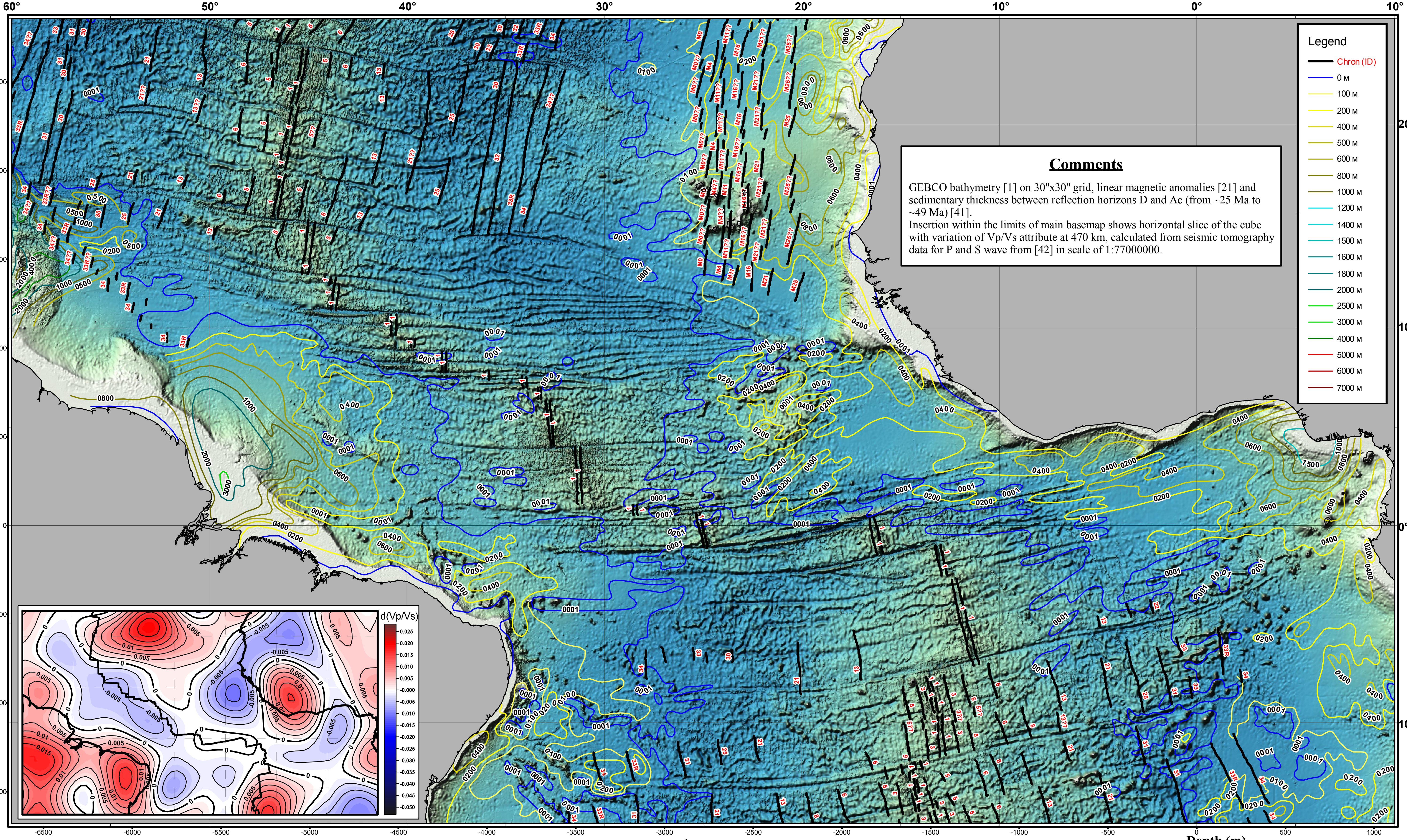


List 26.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK

Thickness of sediments between reflection horizons D and Ac (from ~25 Ma to ~49 Ma) and linear magnetic anomalies



Comments

GEBCO bathymetry [1] on 30"x30" grid, linear magnetic anomalies [21] and sedimentary thickness between reflection horizons D and Ac (from ~25 Ma to ~49 Ma) [41].
Insertion within the limits of main basemap shows horizontal slice of the cube with variation of Vp/Vs attribute at 470 km, calculated from seismic tomography data for P and S wave from [42] in scale of 1:77000000.

km
0 200 400 600 800
Scale 1:20000000 by Equator

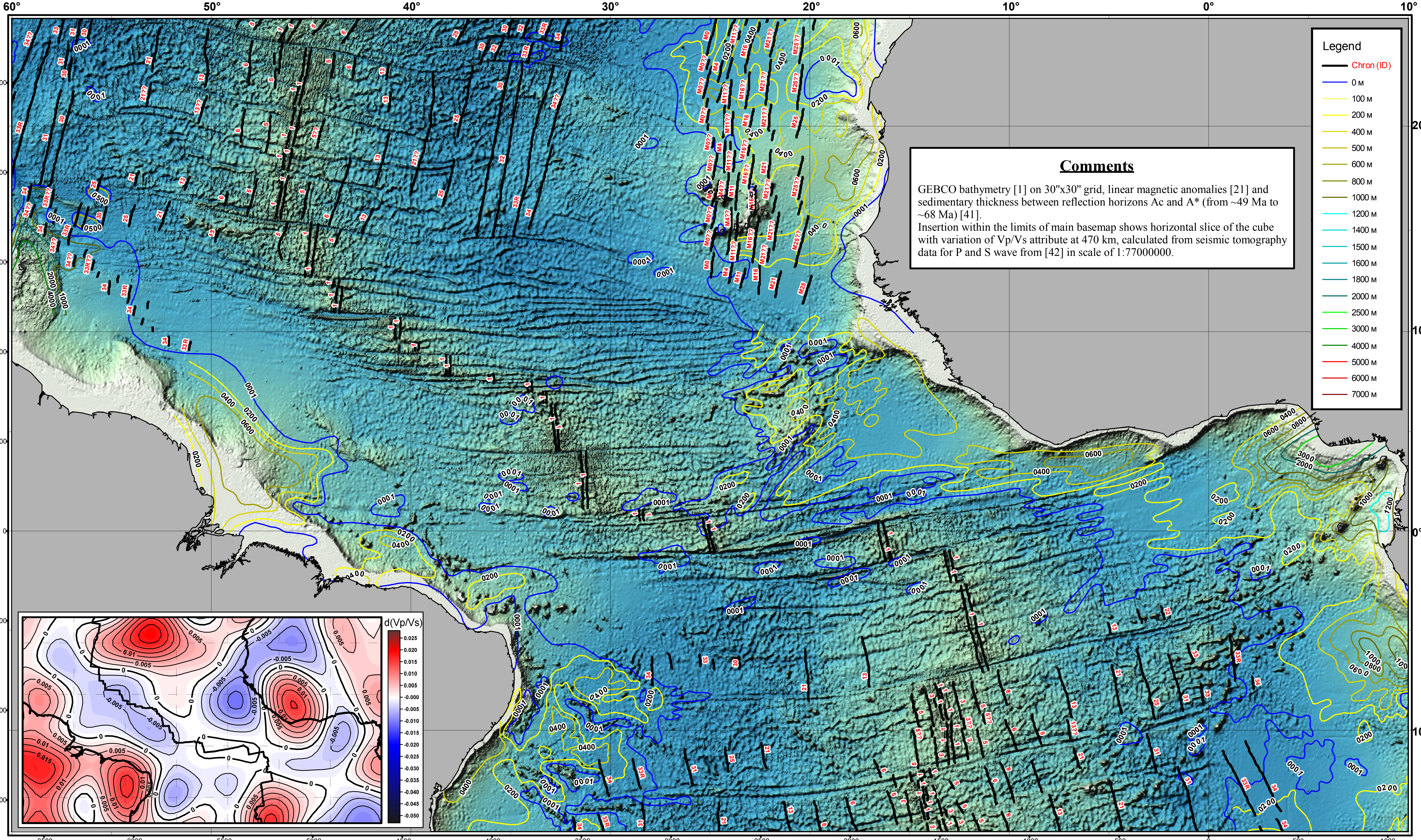
Depth (m)
-7500 -7000 -6500 -6000 -5500 -5000 -4500 -4000 -3500 -3000 -2500 -2000 -1500 -1000 -500 0

List 27. *Sokolov S.Yu.*

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Thickness of sediments between reflection horizons Ac and A* (from ~49 Ma to ~68 Ma) and linear magnetic anomalies

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Comments

GEBCO bathymetry [1] on 30"x30" grid, linear magnetic anomalies [21] and sedimentary thickness between reflection horizons Ac and A* (from ~49 Ma to ~68 Ma) [41].
Insertion within the limits of main basemap shows horizontal slice of the cube with variation of Vp/Vs attribute at 470 km, calculated from seismic tomography data for P and S wave from [42] in scale of 1:77000000.

km
0 200 400 600 800
Scale 1:20000000 by Equator

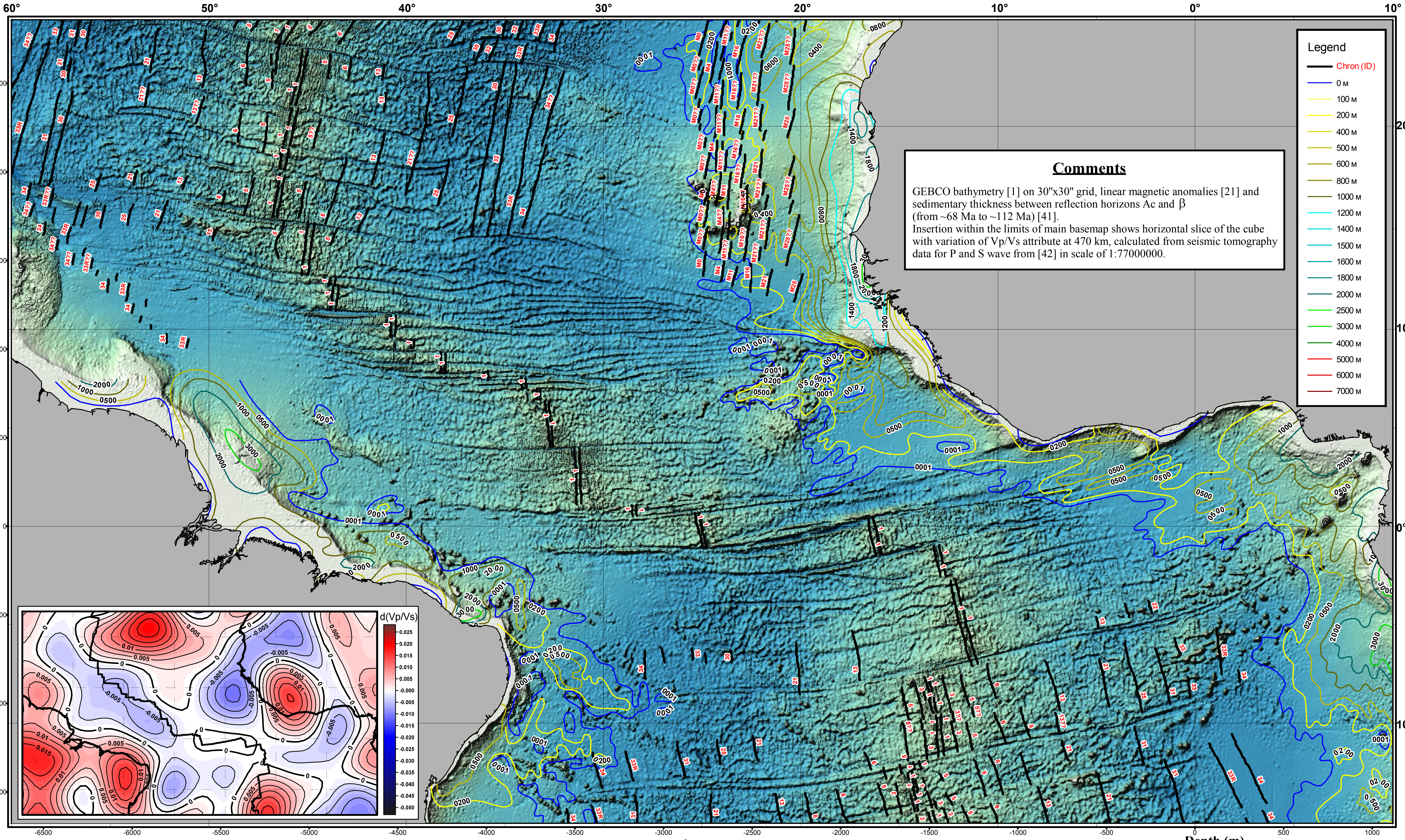
Depth (m)
-7500 -7000 -6500 -6000 -5500 -5000 -4500 -4000 -3500 -3000 -2500 -2000 -1500 -1000 -500 0

List 28.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

Thickness of sediments between reflection horizons A* and β (from ~68 Ma to ~112 Ma) and linear magnetic anomalies

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



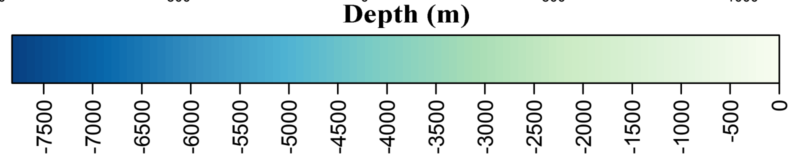
Comments

GEBCO bathymetry [1] on 30"x30" grid, linear magnetic anomalies [21] and sedimentary thickness between reflection horizons Ac and β (from ~68 Ma to ~112 Ma) [41].
Insertion within the limits of main basemap shows horizontal slice of the cube with variation of Vp/Vs attribute at 470 km, calculated from seismic tomography data for P and S wave from [42] in scale of 1:77000000.

List 29. ©2016 *Sokolov S.Yu.*

km
0 200 400 600 800
Scale 1:20000000 by Equator

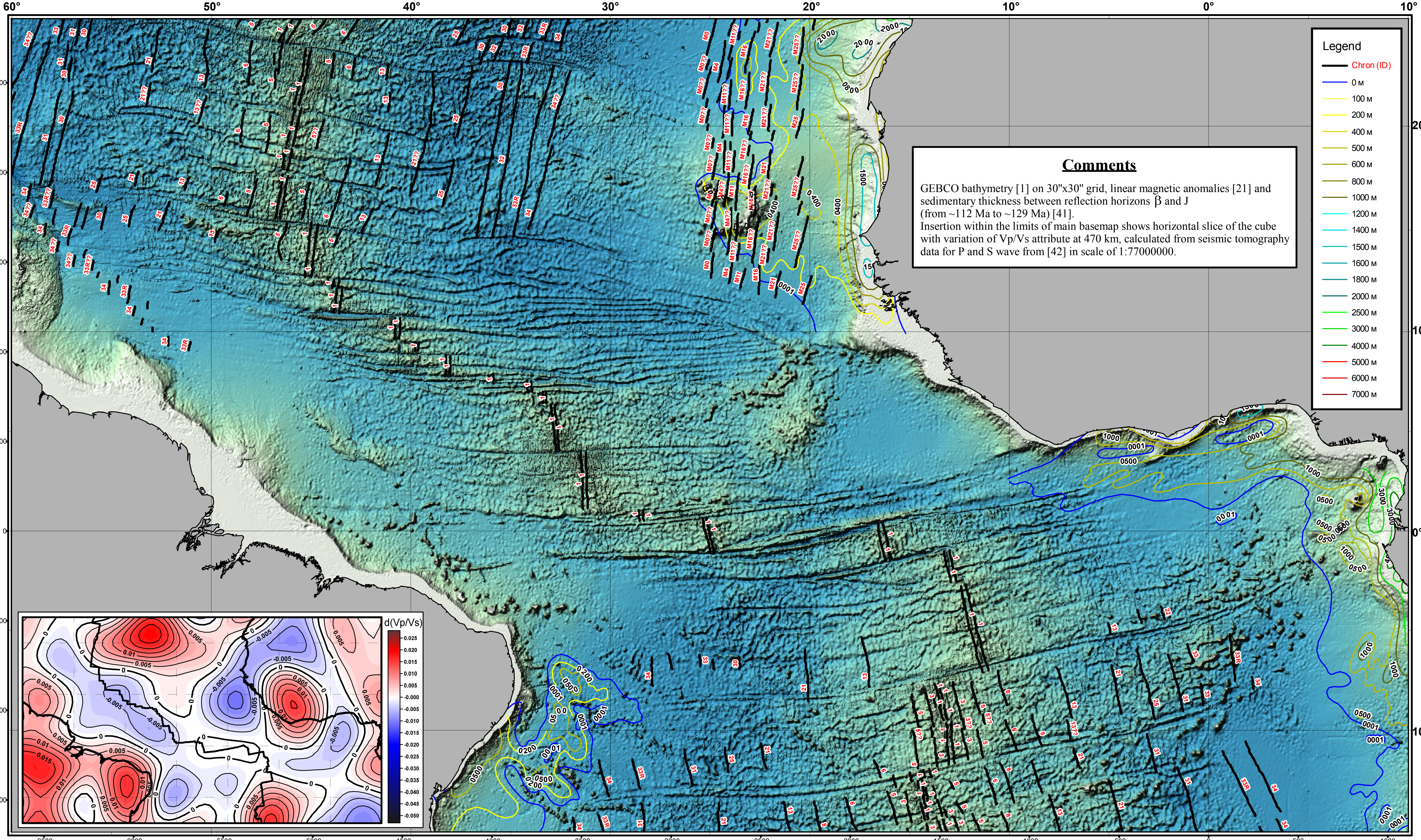
Depth (m)



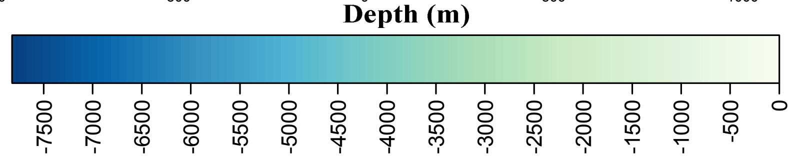
Thickness of sediments between reflection horizons β and J (from ~112 Ma to ~129 Ma) and linear magnetic anomalies

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ РОССИЙСКАЯ АКАДЕМИЯ НАУК

HARD NUT
Laboratory of Geomorphology and Ocean Floor Tectonics
KREPKIY ORESHEK



Depth (m)



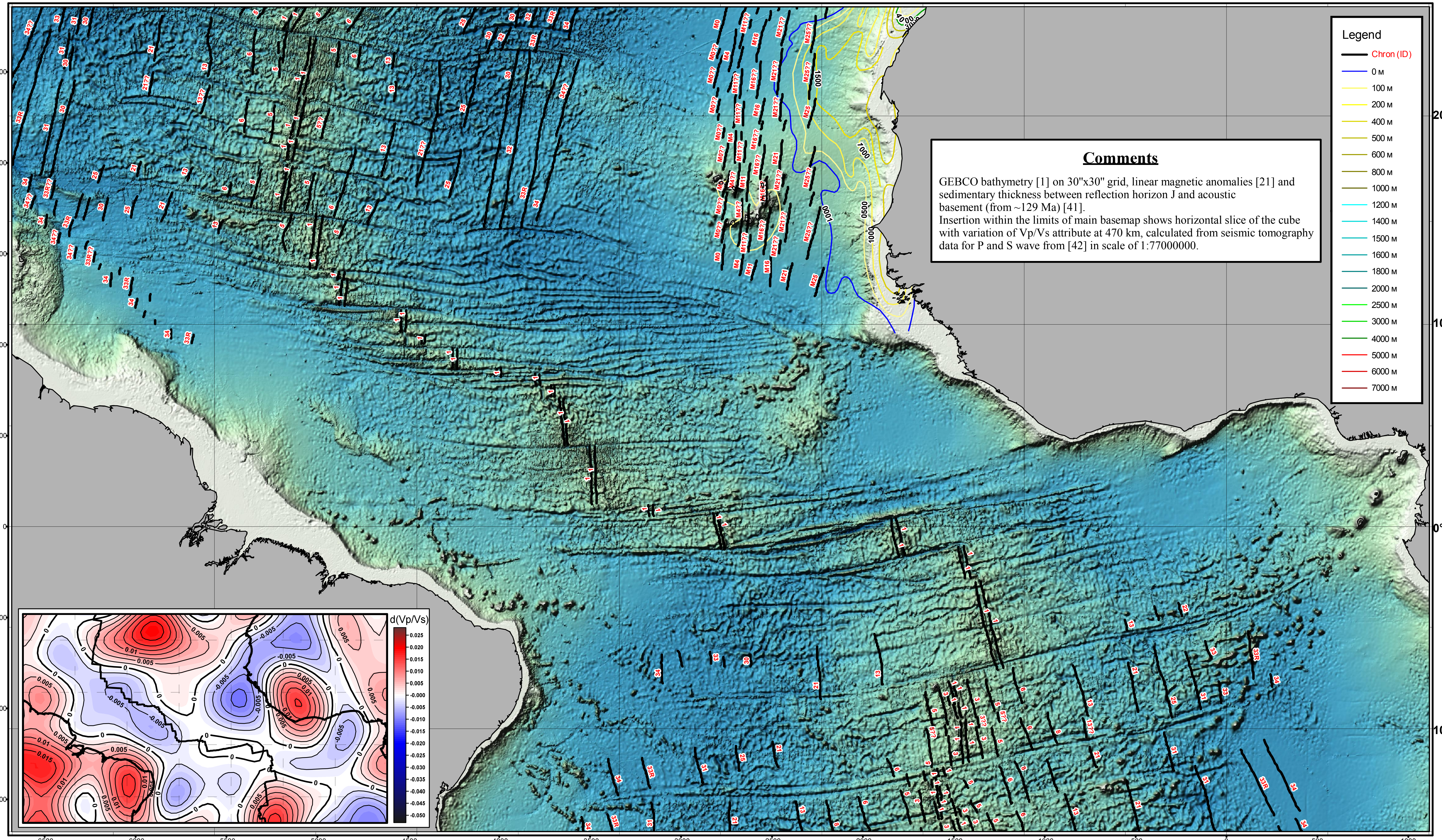
km
0 200 400 600 800
Scale 1:20000000 by Equator

List 30.

ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

Thickness of sediments between reflection horizon J and acoustic basement (from ~129 Ma) and linear magnetic anomalies

HARD NUT
Laboratory of Geomorphology
and Ocean Floor Tectonics
KREPKIY ORESHEK



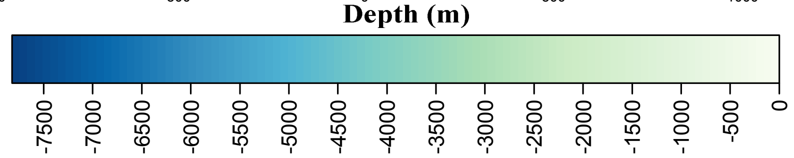
Comments

GEBCO bathymetry [1] on 30"x30" grid, linear magnetic anomalies [21] and sedimentary thickness between reflection horizon J and acoustic basement (from ~129 Ma) [41].
Insertion within the limits of main basemap shows horizontal slice of the cube with variation of Vp/Vs attribute at 470 km, calculated from seismic tomography data for P and S wave from [42] in scale of 1:77000000.

List 31. *Sokolov S.Yu.*

km
0 200 400 600 800
Scale 1:20000000 by Equator

Depth (m)



ГЕОЛОГИЧЕСКИЙ ИНСТИТУТ
РОССИЙСКАЯ АКАДЕМИЯ НАУК

HARD NUT
Laboratory of Geomorphology
and Ocean Floor Tectonics
KREPKIY ORESHEK

Cluster combinations of geophysical parameters with geodynamical interpretation

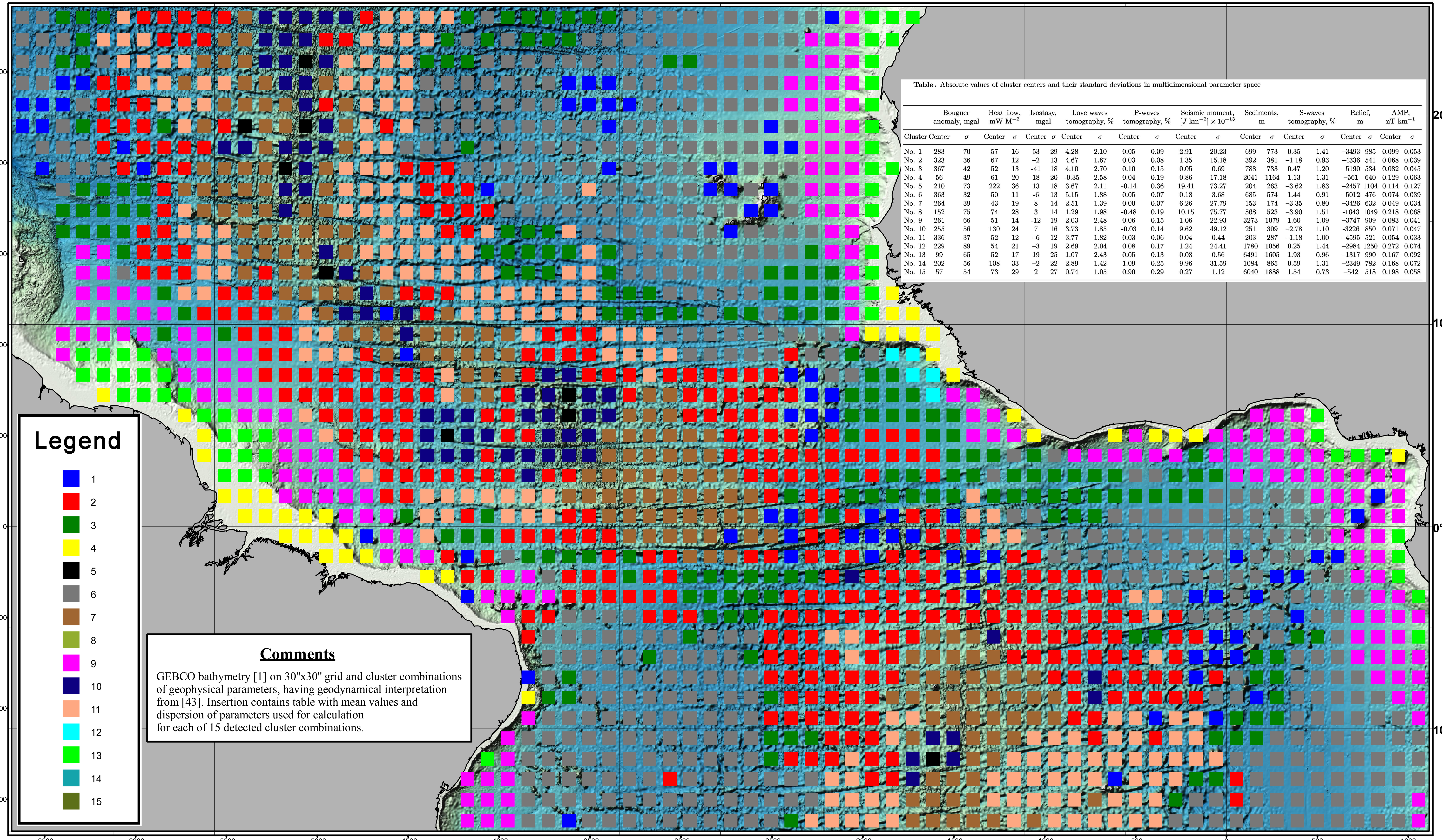


Table. Absolute values of cluster centers and their standard deviations in multidimensional parameter space

	Bouguer anomaly, mgal		Heat flow, mW M^{-2}		Isostasy, mgal		Love waves tomography, %		P-waves tomography, %		Seismic moment, $[J\ km^{-2}] \times 10^{+13}$		Sediments, m		S-waves tomography, %		Relief, m		AMP, nT km^{-1}	
Cluster	Center	σ	Center	σ	Center	σ	Center	σ	Center	σ	Center	σ	Center	σ	Center	σ	Center	σ	Center	σ
No. 1	283	70	57	16	53	29	4.28	2.10	0.05	0.09	2.91	20.23	699	773	0.35	1.41	–3493	985	0.099	0.053
No. 2	323	36	67	12	–2	13	4.67	1.67	0.03	0.08	1.35	15.18	392	381	–1.18	0.93	–4336	541	0.068	0.039
No. 3	367	42	52	13	-41	18	4.10	2.70	0.10	0.15	0.05	0.69	788	733	0.47	1.20	–5190	534	0.082	0.045
No. 4	56	49	61	20	18	20	-0.35	2.58	0.04	0.19	0.86	17.18	2041	1164	1.13	1.31	–561	640	0.129	0.063
No. 5	210	73	222	36	13	18	3.67	2.11	-0.14	0.36	19.41	73.27	204	263	–3.62	1.83	–2457	1104	0.114	0.127
No. 6	363	32	50	11	-6	13	5.15	1.88	0.05	0.07	0.18	3.68	685	574	1.44	0.91	–5012	476	0.074	0.039
No. 7	264	39	43	19	8	14	2.51	1.39	0.00	0.07	6.26	27.79	153	174	–3.35	0.80	–3426	632	0.049	0.034
No. 8	152	75	74	28	3	14	1.29	1.98	-0.48	0.19	10.15	75.77	568	523	–3.90	1.51	-1643	1049	0.218	0.068
No. 9	261	66	51	14	-12	19	2.03	2.48	0.06	0.15	1.06	22.93	3273	1079	1.60	1.09	–3747	909	0.083	0.041
No. 10	255	56	130	24	7	16	3.73	1.85	-0.03	0.14	9.62	49.12	251	309	–2.78	1.10	-3226	850	0.071	0.047
No. 11	336	37	52	12	–6	12	3.77	1.82	0.03	0.06	0.04	0.44	203	287	–1.18	1.00	–4595	521	0.054	0.033
No. 12	229	89	54	21	–3	19	2.69	2.04	0.08	0.17	1.24	24.41	1780	1056	0.25	1.44	–2984	1250	0.272	0.074
No. 13	99	65	52	17	19	25	1.07	2.43	0.05	0.13	0.08	0.56	6491	1605	1.93	0.96	–1317	990	0.167	0.092
No. 14	202	56	108	33	–2	22	2.89	1.42	1.09	0.25	9.96	31.59	1084	865	0.59	1.31	–2349	782	0.168	0.072
No. 15	57	54	73	29	2	27	0.74	1.05	0.90	0.29	0.27	1.12	6040	1888	1.54	0.73	–542	518	0.198	0.058

Comments

GEBCO bathymetry [1] on 30"x30" grid and cluster combinations of geophysical parameters, having geodynamical interpretation from [43]. Insertion contains table with mean values and dispersion of parameters used for calculation for each of 15 detected cluster combinations.

km

0 200 400 600 800

Scale 1:20000000 by Equator

Depth (m)

-7500 -7000 -6500 -6000 -5500 -5000 -4500 -4000 -3500 -3000 -2500 -2000 -1500 -1000 -500 0

List 32.