

Neptune Sandbox Berlin

Johan Renaudie & David Lazarus

Museum für Naturkunde, Berlin

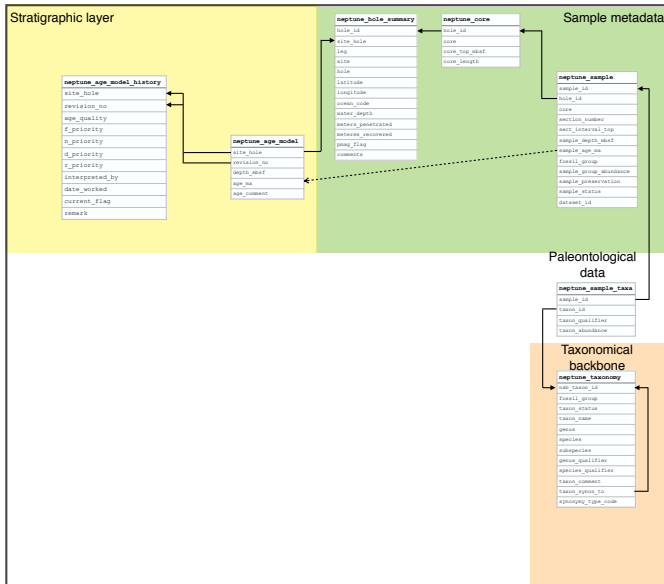
2022-02-10

The Neptune Database

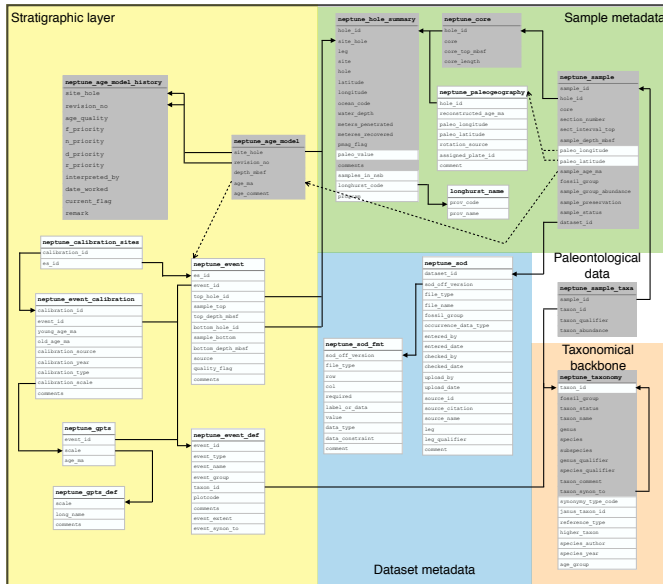
- Started at ETH in Zurich in 1990 as a database of microfossils based on published DSDP and ODP deep-sea drilling data, for paleobiology.
- Put online and updated from 2001 to 2006 as part of NSF-funded Chronos project. Unstable and data damage after project ended late 2000s.
- Salvaged and reopened since 2010 as NSB (Neptune Sandbox Berlin) at the MfN in Berlin, with help of Pat Diver and small grant from CEES Oslo.
- 2014–2015, ESF-funded effort to update it and expand its stratigraphic capabilities for use in paleoceanography.
- Linked to Mikrotax system since 2015.
- Currently run by 2 people (JR, DBL) on voluntary basis.

NSB Structure

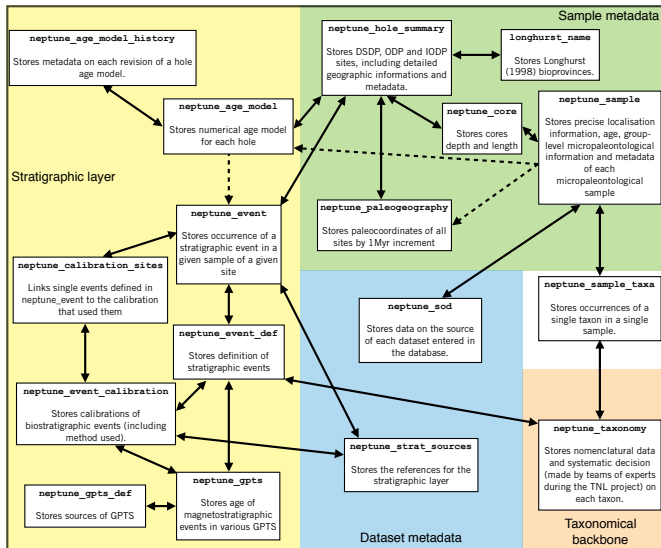
Neptune
prior to
NSB



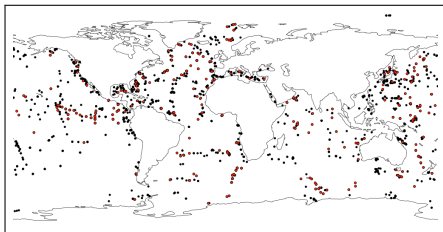
NSB Structure



NSB Structure



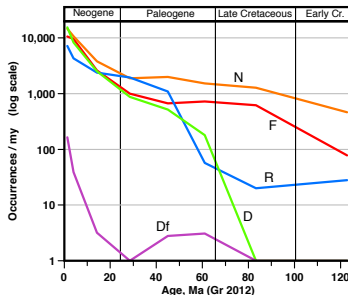
NSB Content



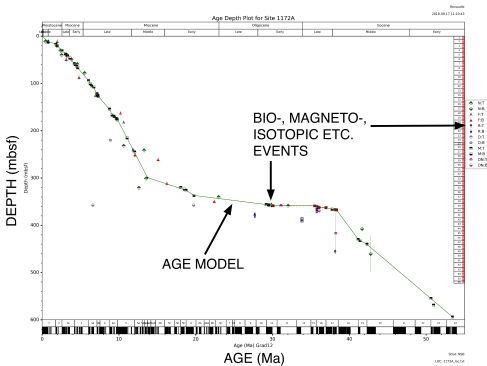
768 057 occurrences.
502 deep-sea drilling holes.
Mostly Cenozoic, but significant Cretaceous.
More carbonate than siliceous fossil data so far.

18 859 taxa names
for 5 microfossil groups
(R, D, PF, N, DN).

Synonymy resolved using TNL:
international effort from IODP
Paleontology Coordination Group.



NSB Content



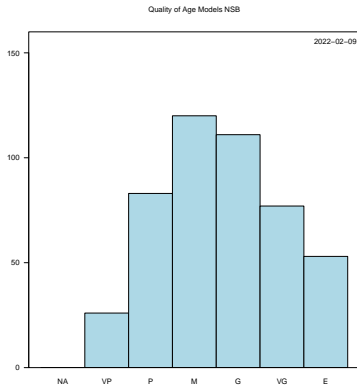
Age model quality vary but most above average.

Website option to ignore poor age models set by default.

Continuous age vs depth functions
(age models) for each section

28 774 stratigraphic events
(including 5 130 calibrations for them)

Age models for 470 DSDP, ODP or IODP holes.



Age model library

neptune_event_def

¹⁴⁶ event_id	¹⁴⁷ event_type	¹⁴⁸ event_name	¹⁴⁹ event_group	¹⁵⁰ taxon_id	¹⁵¹ plotcode	¹⁵² comments	¹⁵³ event_extent	¹⁵⁴ event_synon_to
695	TOP	Turborotalia pomeroli	F	[NULL]	tTURBpome	[NULL]	global	[NULL]
696	BOT	Cribrohantkenina inflata	F	[NULL]	bCRIBinfl	[NULL]	global	[NULL]
697	TOP	Acarinina spp.	F	[NULL]	tACARspp	[NULL]	global	[NULL]
698	TOP	Acarinina collactea	F	[NULL]	tACARcoll	[NULL]	global	[NULL]
699	TOP	Subbotina linaperta	F	[NULL]	tSUBBlina	[NULL]	global	[NULL]
700	TOP	C1n	M	[NULL]	tC1n	Brunhes	global	[NULL]
701	BOT	C1n	M	[NULL]	bC1n	Brunhes	global	[NULL]
702	TOP	C1r.1n	M	[NULL]	tC1r.1n	Jaramillo	global	[NULL]
703	BOT	C1r.1n	M	[NULL]	bC1r.1n	Jaramillo	global	[NULL]

Age model library

neptune_event_def

146 event_id	171 44c event_type	171 44c event_name	171 44c event_group	123 taxon_id	171 44c plotcode	171 44c comments	171 44c event_extent	123 event_synon_to
695	TOP	Turborotalia pomeroli	F	[NULL]	tTURBpome	[NULL]	global	[NULL]
696	BOT	Cribohantkenina inflata	F	[NULL]	bCRIBinfl	[NULL]	global	[NULL]
697	TOP	Acarinina spp.	F	[NULL]	tACARspp	[NULL]	global	[NULL]
698	TOP	Acarinina collactea	F	[NULL]	tACARcoll	[NULL]	global	[NULL]
699	TOP	Subbotina linaperta	F	[NULL]	tSUBBlina	[NULL]	global	[NULL]
700	TOP	C1n	M	[NULL]	tC1n	Brunhes	global	[NULL]
701	BOT	C1n	M	[NULL]	bC1n	Brunhes	global	[NULL]
702	TOP	C1r.1n	M	[NULL]	tC1r.1n	Jaramillo	global	[NULL]
703	BOT	C1r.1n	M	[NULL]	bC1r.1n	Jaramillo	global	[NULL]

neptune_event_calibration

146 calibration_id	123 event_id	44c calibration_source	123 calibration_year	44c calibration_type	44c calibration_scale	123 young_age_ma	123 old_age_ma	44c comments	123 source_id
194	1093	42 Wade et al.	2011	M	42 CK95	38.00	[NULL]	[NULL]	864 42
195	1094	42 Wade et al.	2011	M	42 CK95	40.00	[NULL]	[NULL]	864 42
196	1095	42 Wade et al.	2011	M	42 CK95	27.50	[NULL]	[NULL]	864 42
197	1096	42 Wade et al.	2011	M	42 CK95	28.40	[NULL]	[NULL]	864 42
251	638	42 Cody et al.	2008	M	42 Grad04	3.93	4.19	CONOP Average	658 42
253	640	42 Cody et al.	2008	M	42 Grad04	4.3	4.64	CONOP Average	658 42
250	637	42 Cody et al.	2008	M	42 Grad04	4.58	4.75	CONOP Average	658 42
256	643	42 Cody et al.	2008	M	42 Grad04	4.58	4.74	CONOP Average	658 42
257	644	42 Cody et al.	2008	M	42 Grad04	4.61	4.7	CONOP Average	658 42
254	641	42 Cody et al.	2008	M	42 Grad04	4.3	4.57	CONOP Average	658 42

Age model library

neptune_event_def

141 event_id	142 event_type	143 event_name	144 event_group	145 taxon_id	146 plotcode	147 comments	148 event_extent	149 event_synon_to
695	TOP	Turborotalia pomeroli	F	[NULL]	tTURBpome	[NULL]	global	[NULL]
696	BOT	Cribohantkenina inflata	F	[NULL]	bCRIBinfl	[NULL]	global	[NULL]
697	TOP	Acarinina spp.	F	[NULL]	tACARspp	[NULL]	global	[NULL]
698	TOP	Acarinina collectea	F	[NULL]	tACARcoll	[NULL]	global	[NULL]
699	TOP	Subbotina linaperta	F	[NULL]	tSUBBlina	[NULL]	global	[NULL]
700	TOP	C1n	M	[NULL]	tC1n	Brunhes	global	[NULL]
701	BOT	C1n	M	[NULL]	bC1n	Brunhes	global	[NULL]
702	TOP	C1r.1n	M	[NULL]	tC1r.1n	Jaramillo	global	[NULL]
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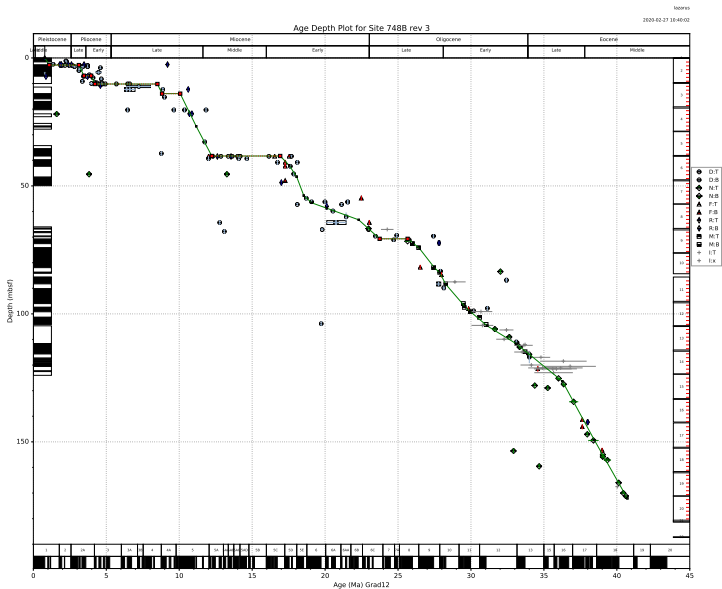
neptune_event_calibration

150 calibration_id	151 event_id	152 calibration_source	153 calibration_year	154 calibration_type	155 calibration_scale	156 young_age_ma	157 old_age_ma	158 comments	159 source_id
194	1093	Wade et al.	2011	M	CK95	38.00	[NULL]	[NULL]	864
195	1094	Wade et al.	2011	M	CK95	40.00	[NULL]	[NULL]	864
196	1095	Wade et al.	2011	M	CK95	27.50	[NULL]	[NULL]	864
197	1096	Wade et al.	2011	M	CK95	28.40	[NULL]	[NULL]	864
251	638	Cody et al.	2008	M	Grad04	3.93	4.19	CONOP Average	658
253	640	Cody et al.	2008	M	Grad04	4.3	4.64	CONOP Average	658
250	637	Cody et al.	2008	M	Grad04	4.58	4.75	CONOP Average	658
256	643	Cody et al.	2008	M	Grad04	4.58	4.74	CONOP Average	658
257	644	Cody et al.	2008	M	Grad04	4.61	4.7	CONOP Average	658
254	641	Cody et al.	2008	M	Grad04	4.3	4.57	CONOP Average	658

neptune_event

160 es_id	161 event_id	162 top_hole_id	163 sample_top	164 top_depth_mbsf	165 bottom_hole_id	166 sample_bottom	167 bottom_depth_mbsf	168 source	169 source_id
24736	1080	111,677A	16-CC	148.59	111,677A	17-CC	151.57	Houghton 1989	701
21733	111	111,677A	19-CC	172.47	111,677A	20-CC	180.67	Houghton 1989	701
23159	1076	111,677A	12-3,95	105.15	111,677A	12-CC	110.84	Houghton 1989	701
24170	93	111,677A	6-3,10	47.30	111,677A	6-6,78	52.48	Houghton 1989	701
18415	934	111,677A	24-3,65	215.35	111,677A	24-CC	221.05	Houghton 1989	701
12596	1085	111,677A	16-CC	148.59	111,677A	17-CC	151.57	Jenkins & Houghton 1989	705
21650	940	111,677A	20-CC	180.67	111,677A	21-CC	185.57	Houghton 1989	701
11933	9	111,677A	10-2,150	85.20	111,677A	10-3,130	86.50	Jenkins & Houghton 1989	705
22195	1071	111,677A	7-3,45	57.15	111,677A	7-6,84	62.04	Houghton 1989	701
21852	933	111,677A	19-CC	172.47	111,677A	20-CC	180.67	Houghton 1989	701
19891	106	111,677A	29-CC	265.26	111,677A	30-CC	275.48	Houghton 1989	701

Age model library



Age model library

neptune_age_model

site_hole	revision_no	age_ma	depth_mbsf	age_comment
762C	1	34.085972	168.182	[NULL]
762C	1	37.340460	263.864	[NULL]
762C	1	40.438657	277.727	[NULL]
762C	1	43.397971	277.727	[NULL]
762C	1	47.254786	330.475	[NULL]
762C	1	52.613917	369.525	[NULL]
762C	1	57.097708	420.455	[NULL]
762C	1	62.548715	519.045	[NULL]
762C	1	63.420985	519.045	[NULL]
762C	1	65.778689	553.273	[NULL]
762C	1	69.666593	603.458	[NULL]
762C	1	75.366248	616.292	[NULL]
762C	1	85.599852	782.273	[NULL]
762C	1	95.659265	806.676	[NULL]
762C	1	104.539295	825.143	[NULL]
762C	1	111.684952	825.143	[NULL]
762C	1	122.542580	841.651	[NULL]
762C	1	144.282300	841.651	[NULL]

Age model library

neptune_age_model

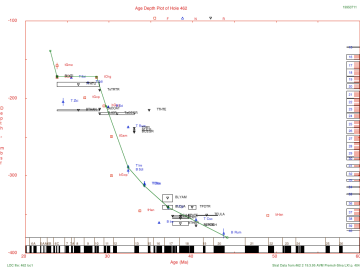
site_hole	revision_no	age_ma	depth_mbsf	age_comment
762C	1	34.085972	168.182	[NULL]
762C	1	37.340460	263.864	[NULL]
762C	1	40.438657	277.727	[NULL]
762C	1	43.397971	277.727	[NULL]
762C	1	47.254786	330.475	[NULL]
762C	1	52.613917	369.525	[NULL]
762C	1	57.097708	420.455	[NULL]
762C	1	62.548715	519.045	[NULL]
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762C	1	85.599852	782.273	[NULL]
762C	1	95.659265	806.676	[NULL]
762C	1	104.539295	825.143	[NULL]
762C	1	111.684952	825.143	[NULL]
762C	1	122.542580	841.651	[NULL]
762C	1	144.282300	841.651	[NULL]

neptune_age_model_history

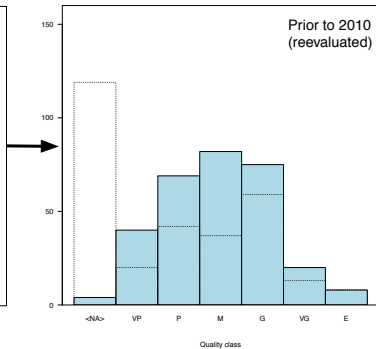
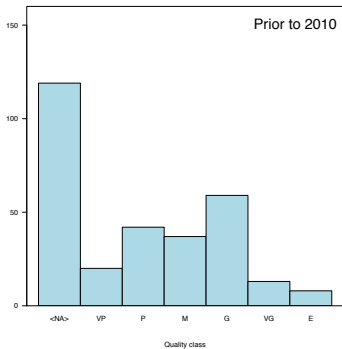
site_hole	revision_no	age_quality	interpreted_by	date_worked	current_flag	remark
1337A	0	VG	Renaudie	2015-04-13	N	Qest by dbl
1337A	1	VG	lazarus	2017-03-08	N	Qest by dbl 8.3.17. Minor shifts of loc to better match fuller set of data added to NSB after rev0 loc by Renaudie
1337A	2	E	lazarus	2021-12-21	Y	Qest dbl. Orbitally tuned upper 2/3, near constant sed rate tuned section supports loc w. only bstrat in lower part
1337B	0	E	lazarus	2021-12-30	Y	Qest dbl. Orbitally tuned. plot labeled Rev2 to match 1337A
1337D	0	E	lazarus	2021-12-30	Y	Qest dbl. Orbitally tuned.
1338A	0	G	Renaudie	2015-04-13	N	Qest by dbl 6.2.17. Excellent model now avail: Backman et al. 2016 IOOP Leg SR vol online. JR (2015): uses IR magneto; M disagrees w
1338A	1	N/A	lazarus	2022-01-30	Y	[NULL]
1338B	0	G	Renaudie	2015-04-13	N	Qest by dbl 6.2.17. Excellent model now avail: Backman et al. 2016 IOOP Leg SR vol online. JR (2015): uses IR magneto; M disagrees w
1338B	1	G	lazarus	2017-04-06	N	Qest by dbl 6.4.17. Also in comparison to 1338A. Pmag coverage spotty, some scatter. Loc could be moved ca 5 to max 1 my at some s
1338B	2	N/A	lazarus	2022-01-30	Y	[NULL]

Quality Control

Age model assessment



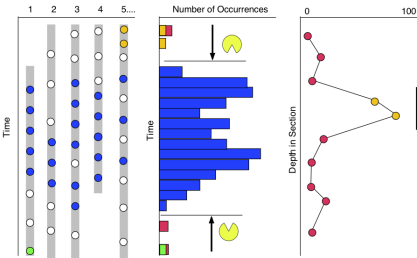
- New quality assessment of old Chronos-era age models



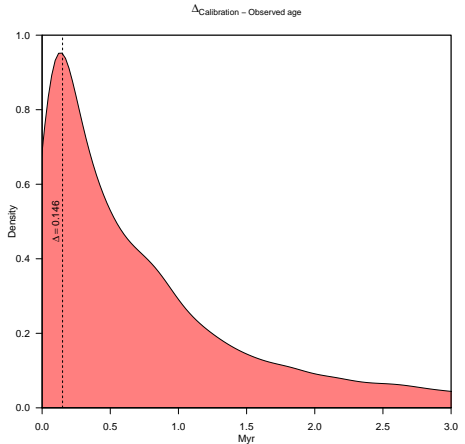
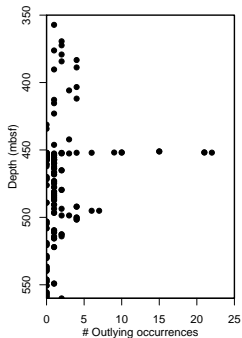
Quality Control

Pacman

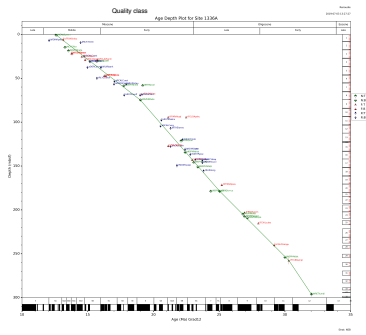
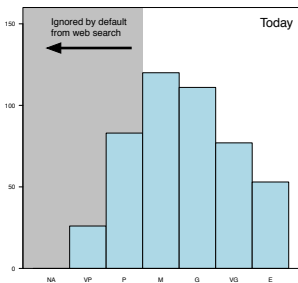
- New quality assessment of old Chronos-era age models
- Outlier detection using e. g. PacMan analysis (Lazarus et al. 2012)



525A

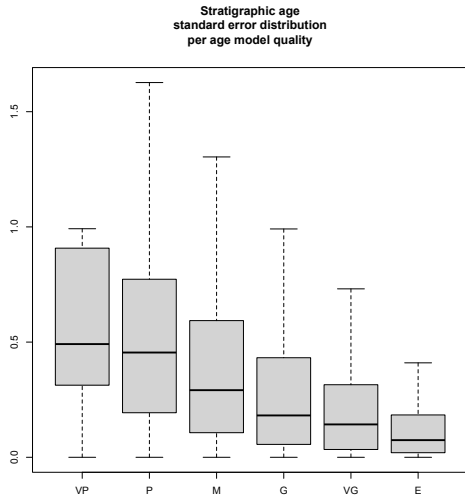
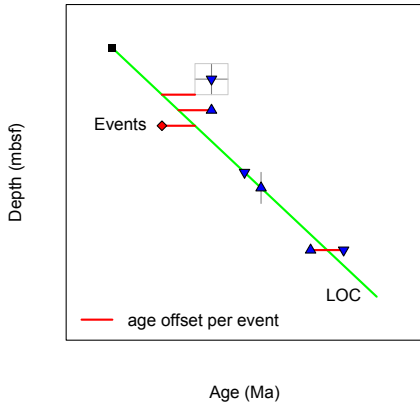


Quality Control



- New quality assessment of old Chronos-era age models
- Outlier detection using e. g. PacMan analysis (Lazarus et al. 2012)
- Selected undated holes containing the larger amount of samples
- Re-did main offenders by using modern calibrations and newly published stratigraphic events (including astrochronology)
- Added possibility to filter out datasets with poor age models on the web portal
- > 300 new/revised age models since 2014; including >100 since 2020.

Error estimates on age models



Age model quality estimate qualitative but match quantitative estimates: **VP**: LOC poorly constrained; **P**: median error ca. $\pm 0.45\text{Myr}$; **M**: ca. $\pm 0.30\text{Myr}$; **G**: ca. $\pm 0.20\text{Myr}$; **VG**: ca. $\pm 0.15\text{Myr}$; **E**: ca. $\pm 0.075\text{Myr}$.

Neptune Sandbox Berlin

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Leibniz



2019 Johan Renaudie.



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About

NSB is the current implementation of the Neptune database (Lazarus, 1994; Spencer-Cervato, 1999). It holds hundreds of thousands of occurrence records for thousands of marine plankton microfossil species from hundreds of deep-sea ocean drilling sections; a taxonomic name management list; age models for all sections; and the geochronologic data used to create these age models. NSB serves several distinct groups of users including microfossil taxonomists, evolutionary (paleo)biologists, and paleoceanographers. A selection of papers that have used Neptune/NSB data is given below, and a full list of all papers using, describing or mentioning the database is given [here](#).

NSB also provides data services to the [Mikrotax](#) community catalog of microfossils and to the [Geobiodiversity Database](#) (GBDB).

NSB is free to use. User accounts are employed to maintain database security and provide feedback on user needs, and can be obtained simply with an email to one of NSB's managers ([see here](#)). The only obligation is to cite the database properly ([references here](#)) in any publications or public presentations.

Twenty selected papers using NSB

Lazarus, D. 1994. Neptune: a marine micropaleontology database. *Mathematical Geology*, 26(7):817-832.

Spencer-Cervato, C., Thierstein, H. R., Lazarus, D. B., and Beckmann, J. P. 1994. How synchronous are Neogene marine plankton events? *Paleoceanography*, 9:739-763.

Finkel, Z. V., Katz, M. E., Wright, J. D., Schofield, D., and Falkowski, P. 2005. Climatically driven macroevolutionary patterns in the size of marine diatoms over the Cenozoic. *Proceedings of the National Academy of Sciences of the United States of America*, 102(25):8927-8932.

Allen, A. P., Gillooly, J. F., Savage, V. M., and Brown, J. H. 2006. Kinetic effects of temperature on rates of genetic divergence and speciation. *Proceedings of the National Academy of Sciences of the United States of America*, 103(24):9130-9135.

Liu, L. H. and Stenseth, N. C. 2007. The rise and fall of species: implications for macroevolutionary and macroecological studies. *Proceedings of the Royal Society B*, 274(1626):2745-2752.

Muttoni, G. and Kent, D. 2007. Widespread formation of cherts during the early Eocene climatic optimum. *Paleogeography, Palaeoclimatology, Palaeoecology*, 253(3-4):348-362.

Rabosky, D. L. and Sornhann, U. 2009. Diversity dynamics of marine planktonic diatoms across the Cenozoic. *Nature*, 247:183-187.

Cermeño, P. and Falkowski, P. G. 2009. Controls on diatom biogeography in the ocean. *Science*, 325:1539-1541.

Fils, D., Cervato, C., Reed, J., Diver, P., Tang, X., Böhlert, G., and Greer, D. 2009. CHRONOS architecture: Experiences with an open-source services- oriented architecture for geoinformatics.

Environmetrics and Bioinformatics 5(6):776-782

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Hole

1338A

Scale

Gradstein et al. 2012

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Revision 0

Interpreted
by

Renaudie

Date

April 13, 2015

Age
Quality

G

Currently used in NSB

Y

Remarks

*Qest by dpl 6.2.17. Excellent model now avail: Backman et al. 2016 IODP Leg SR
vol online. JR (2015); uses IR magneto; M disagrees with biostrat between 200
and 300 mbsf*

Hole	Age (Ma)	Depth (mbsf)	Comment
1338A	0.000000	0.000	None
1338A	0.782725	8.276	None
1338A	1.109405	11.971	None
1338A	1.762765	21.207	None
1338A	2.579465	31.368	None
1338A	3.118487	37.833	None
1338A	3.330829	40.142	None
1338A	3.608507	43.837	None
1338A	4.180197	51.688	None
1338A	4.376205	54.459	None
1338A	5.029564	66.929	None



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Event Scale

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Event ID	Calib. ID	Type	Event Name	Group	Age min	Age max	Geographical Extent	Source	Calibration Type	Original Scale	Comments
1073	1210	BOT	Emiliania huxleyi	N	0.3		global	Berggren et al. 1985	M	Berg85	OOP Technical Note 24
1073	174	BOT	Emiliania huxleyi	N	0.29		global	Backman et al. 2012	O	Grad04	

All ages given here on Gradstein et al. 2012 scale.

This event has been found in the following sites:

TOP				BOTTOM				Source event	Comment	
Event ID	Hole	Sample	Depth (mbsf) (*)	Age (mbsf) (*)	Hole	Sample	Depth (mbsf) (*)			
1073	101_626C	5-1.40	38.90		101_626C	5-CC	48.01	626C_fn_bstrat95		
1073	104_642B	2-6.85	13.15		104_642B	3-2.87	16.67	Donnelly 1989		
1073	104_643A	1-2.50	2.00	0.278	104_643A	1-3.50	3.50	Donnelly 1989		
1073	104_644A	4-1.50	26.20		104_644A	4-2.50	27.70	644A_mfnr_bstrat95		
1073	105_646A	2-5.102	12.02	0.184	105_646A	2-6.104	13.54	0.207 Baldauf et al 1989		
1073	105_646B		12.03	0.182	105_646B		13.55	0.2 Baldauf et al 1989		
1073	105_647A	1-6.130	8.80	0.275	105_647A	1-7.14	9.14	0.285 647A_mfn_bstrat95		
1073	107_651A	8-CC	64.42		107_651A	9-1.69	69.49	651A_mn_bstrat95		
1073	107_653A	3-2.60	15.30		107_653A	3-2.120	15.90	Rio et al. 1990	Used for calibration of the event (see calibration No 174).	
1073	107_653A		15.60		107_653A		15.60	Glaçon et al 1990		
1073	107_655A	1-2.20	1.70		107_655A	1-2.120	2.70	Müller 1990		
1073	108_657A		0.90		108_657A		3.30	657A_fn_bstrat95		
1073	108_658A		34.20	0.275	108_658A		43.70	0.318 Manivit 1989		
1073	108_658A		34.20	0.275	108_658A		43.70	0.318 658A_mfn_bstrat95		
1073	108_659A	1-5.130	7.30	0.241	108_659A	2-1.30	8.10	0.27 Manivit 1989		

Web portal: nsb.mfn-berlin.de

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Hole

320-1333A

Scale

Gradstein et al. 2012

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Type	Event Name	Sample (Top)	Sample (Bottom)	Depth mbsf (Top)	Depth mbsf (Bottom)	Age min	Age max	Source event	Source calibration	Comment
M TOP	C6An.1n	320_1333A- 1-1,55	320_1333A- 1-1,65	0.55	0.65	20.04		Expedition 320/321 Scientists, 2010	Gradstein et al. 2012	
M BOT	C6An.1n	320_1333A- 1-1,110	320_1333A- 1-1,115	1.10	1.15	20.21		Expedition 320/321 Scientists, 2010	Gradstein et al. 2012	
M TOP	C6An.2n	320_1333A- 1-2,50	320_1333A- 1-2,60	2.00	2.10	20.44		Expedition 320/321 Scientists, 2010	Gradstein et al. 2012	
R BOT	Stichocorys delmontensis	320_1333A- 1-2,104	320_1333A- 1-4,104	2.54	5.54	20.6		Expedition 320/321 Scientists, 2010	Kamikuri et al. 2012	Used for age model revision 0
R BOT	Stichocorys delmontensis	320_1333A- 1-2,104	320_1333B- 1-2,104	2.54	7.49	20.6		Kamikuri et al.	Kamikuri et al.	Used for

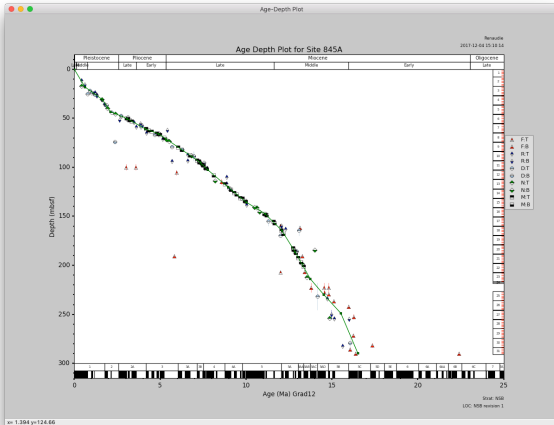


Libriz



NSB_ADP_wx

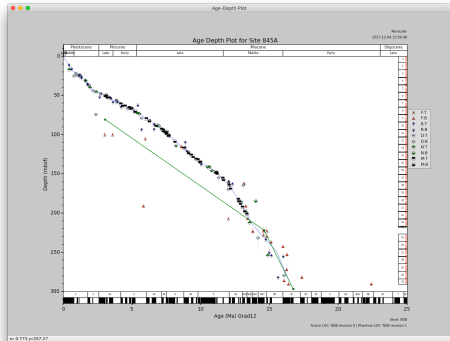
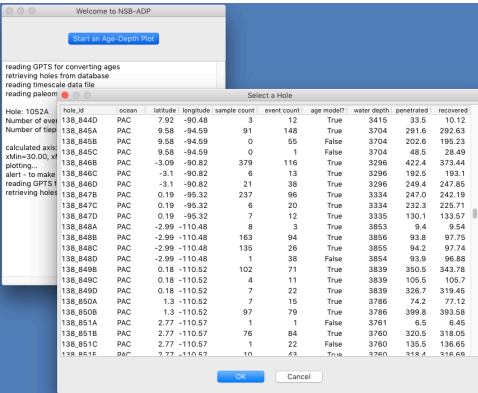
Currently available for Mac OSX 10.12 and higher, or as a python script, at http://github.com/plannapus/nsb_adp_wx/releases.



Modernisation of
Age-Depth plot
software (Lazarus,
1992; Bohling, 2005)

NSB_ADP_wx

Allows users to create an age model, to explore NSB age model and biostratigraphic events library, to modify an existing age model, compare alternative ones, etc.



Future of NSB and associated software stack

- Triton integration
- Ability to work with mcd in addition to mbsf
- API for stratigraphic data
- Ability to store paleomagnetic raw data to allow new interpretations and error quantification
- NSB_ADP_shiny? Web-based age-depth plot maker with direct connection to DB would increase its accessibility

Additional informations.

Access to the Database:

Website: <http://nsb.mfn-berlin.de>

Username: guest

Password: arm_aber_sexy

For direct PostgreSQL connection:

Host: 212.201.100.111

Port: 5432

Database name: nsb

NSB_ADP_wx: http://github.com/plannapus/nsb_adp_wx/releases

Renaudie, J., Lazarus, D.B., Diver, P. (2020) NSB (Neptune Sandbox Berlin): an expanded and improved database of marine planktonic microfossil data and deep-sea stratigraphy. *Palaeontologia Electronica*, 23(1):a11.