



NSDL/NSTA Web Seminar:

**Earth in Reverse: Magnetic Wiggles on the
Ocean Floor**



Tuesday, January 29, 2008



Today's NSDL Experts



Dr. Chris Massell Symons, Researcher at the Scripps Institution of Oceanography



Dr. Anthony Koppers, Associate Professor of Marine Geology and Geophysics at Oregon State University



<http://earthref.org/ERESE>



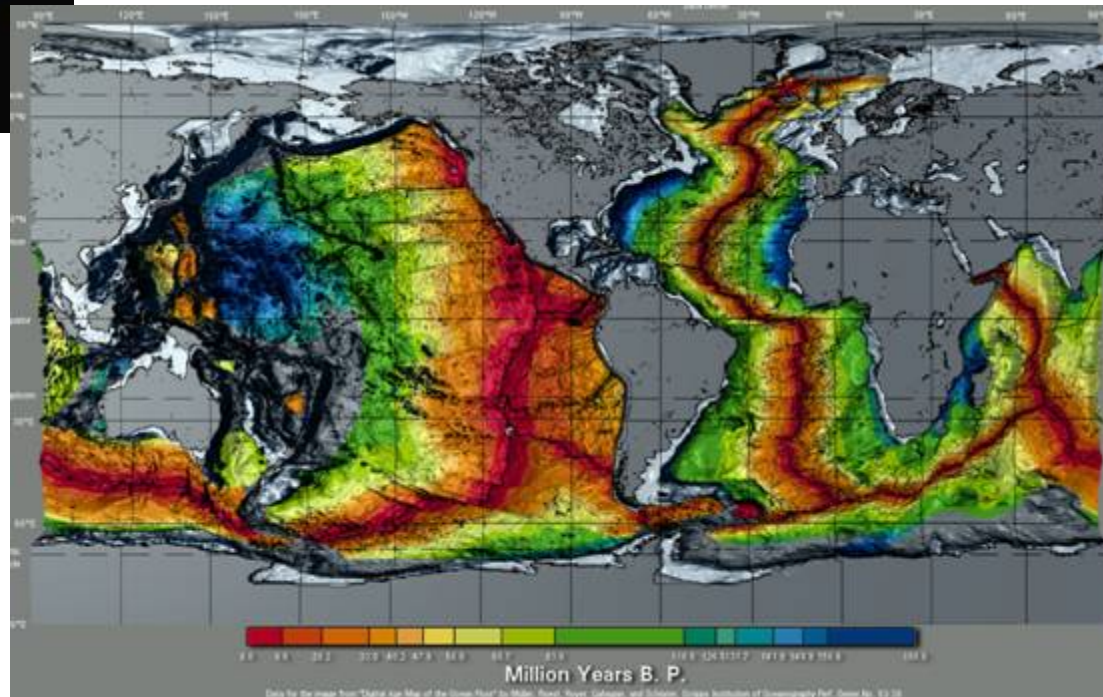
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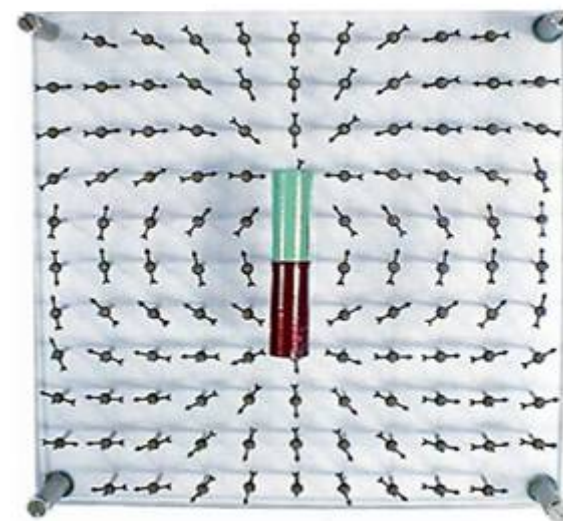
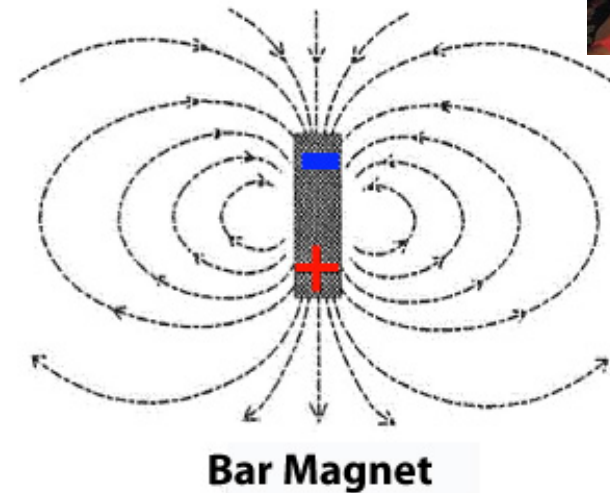
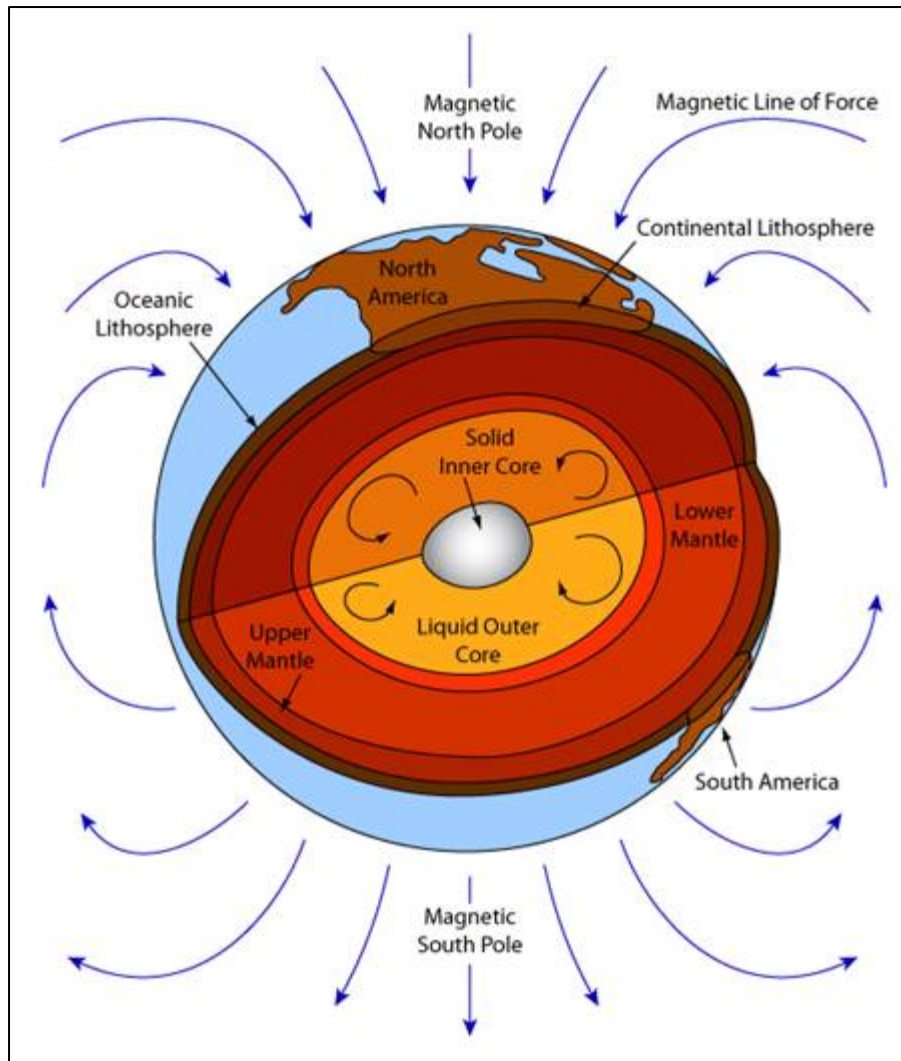


How did we get from
“blue” oceans to such
great detail?

Magnetic Wiggles!!!

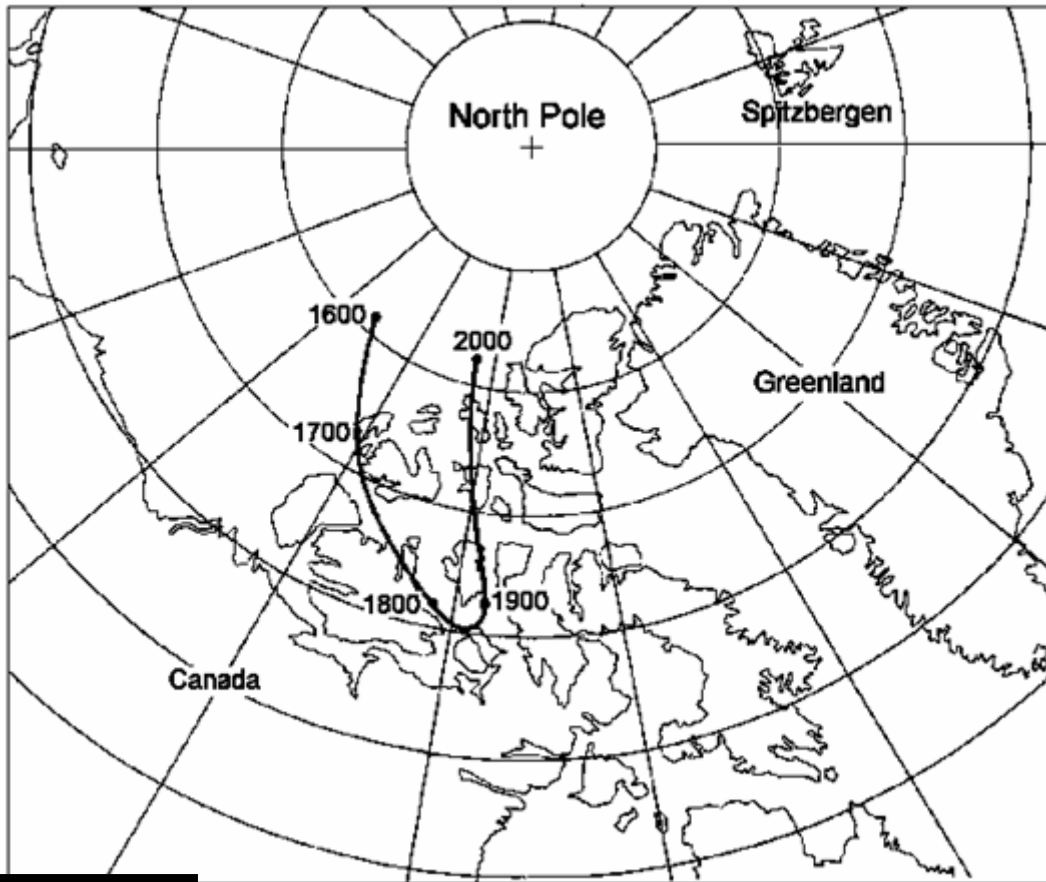


Earth's Magnetic Field





BUT.....Magnetic North is NOT at the North Pole

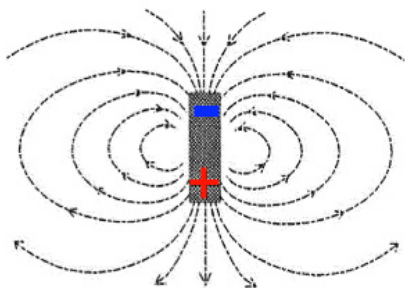




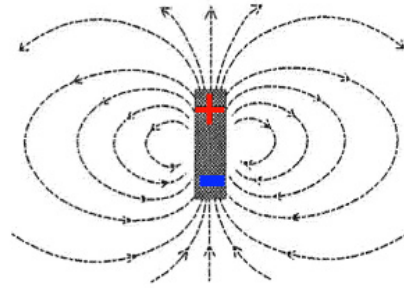
AND...the Magnetic Field Reverses

- Field reverses ~1 time every 200,000 years on average.
- 400 times in last 330 million years.
- Last reversal was 780,000 years ago.

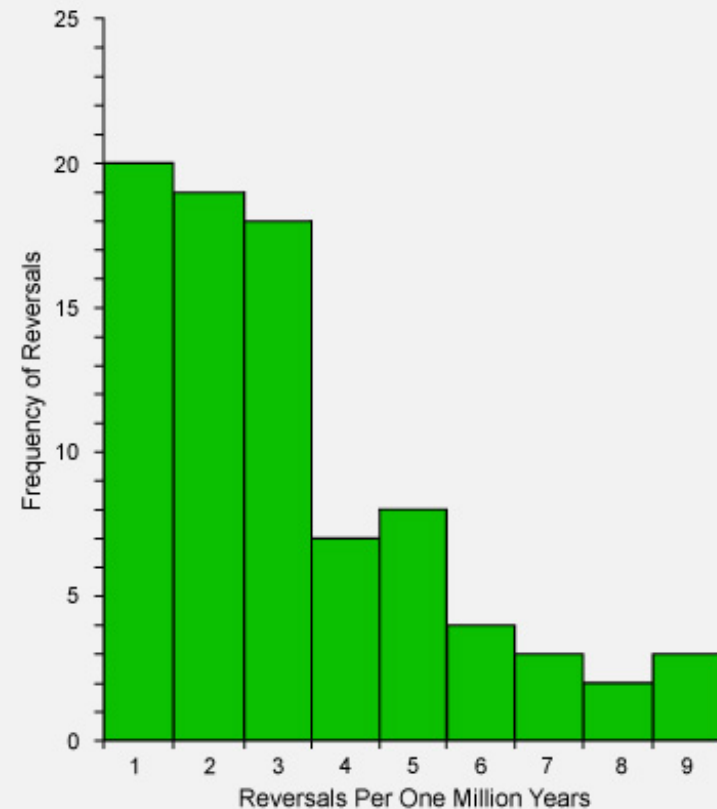
NORMAL



REVERSE



Magnetic Reversal Data Table





Poll Question!

On average, how long does each magnetic reversal take to complete?

- A. 10,000 years
- B. 5,000 years
- C. 1,000 years
- D. 100 years







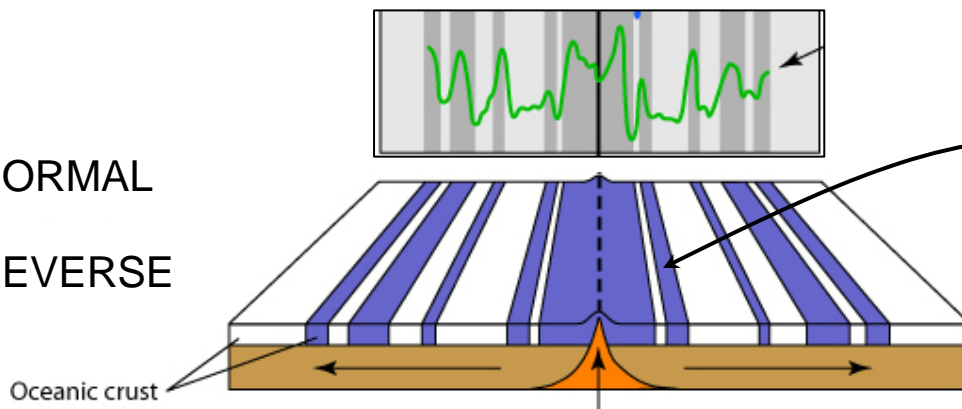
Let's pause for
two questions
from the
audience....



signature

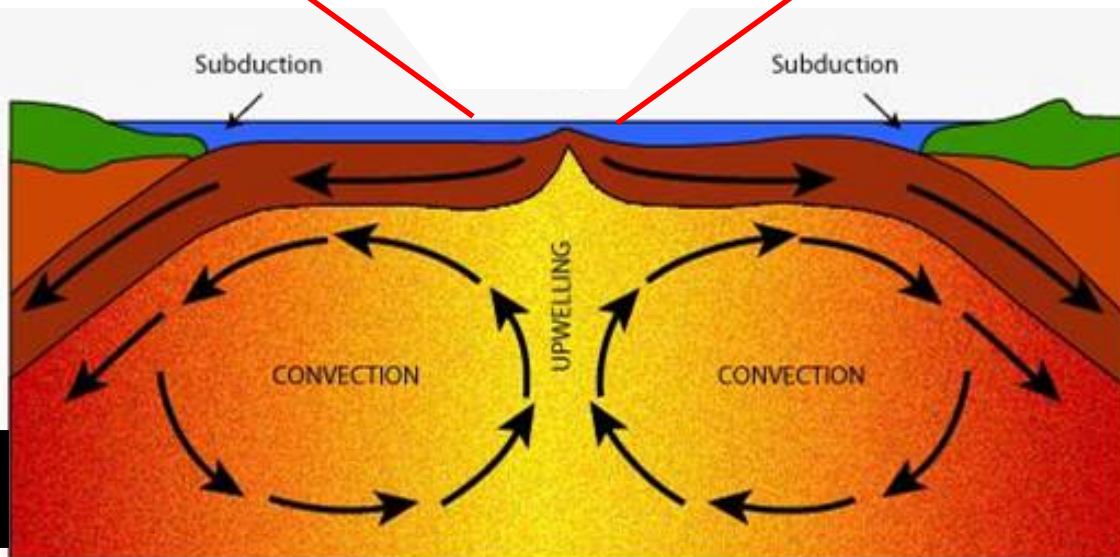


 NORMAL
 REVERSE

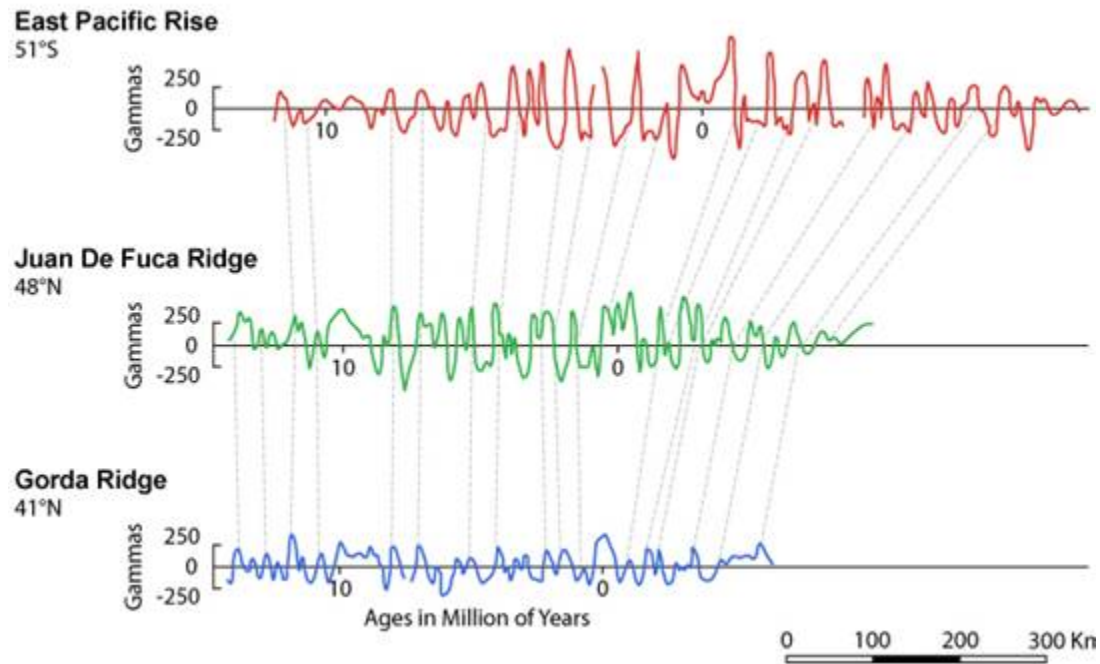


MID-OCEAN RIDGE

<http://usgs.gov>

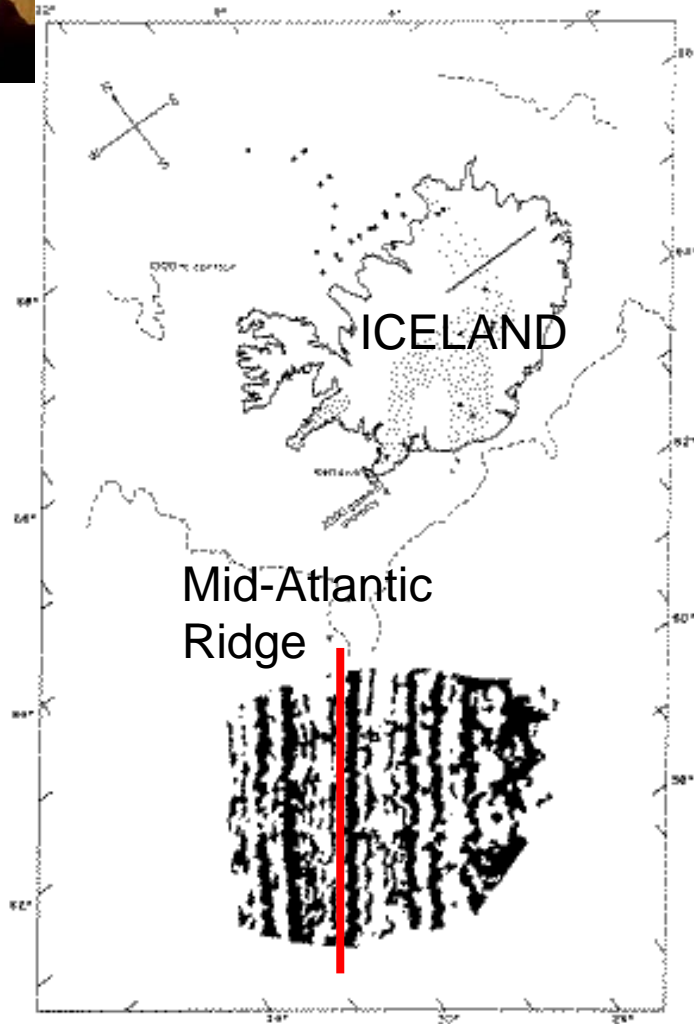


Sampling the Seafloor

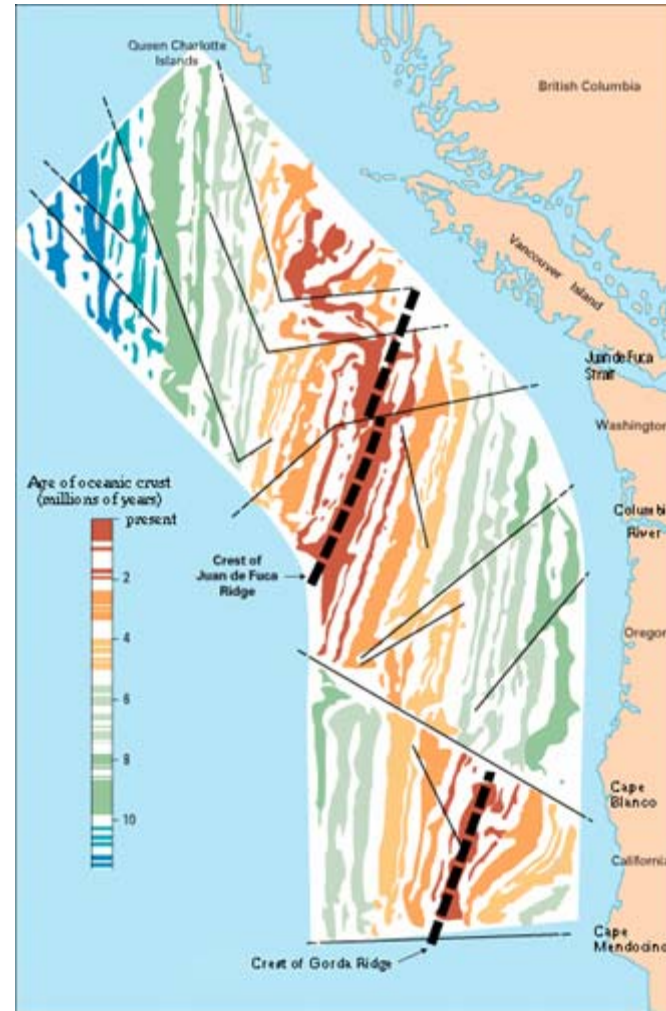




Early Maps of Seafloor Anomalies



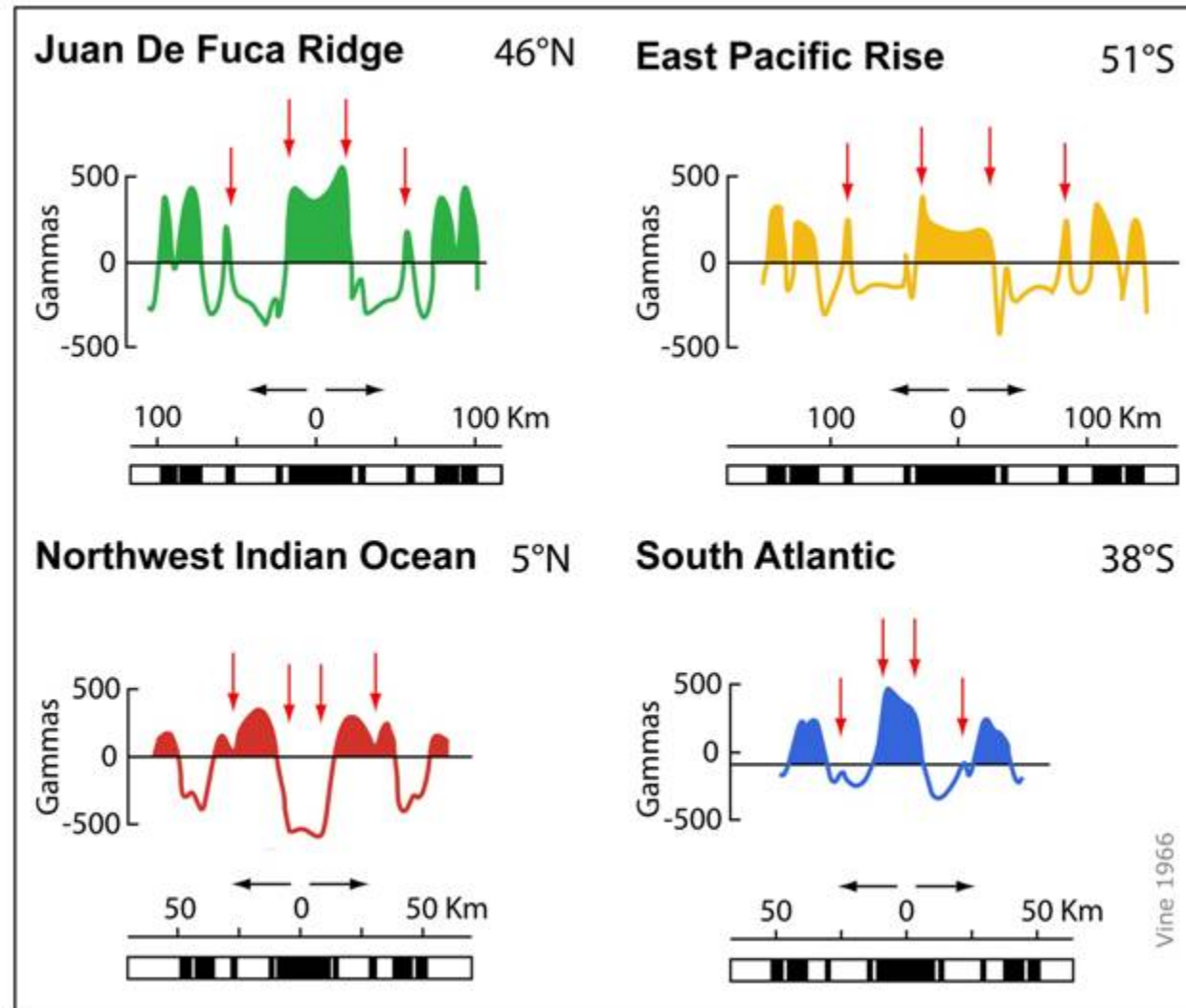
Heirtzler et al., 1966



Raff and Mason, 1961

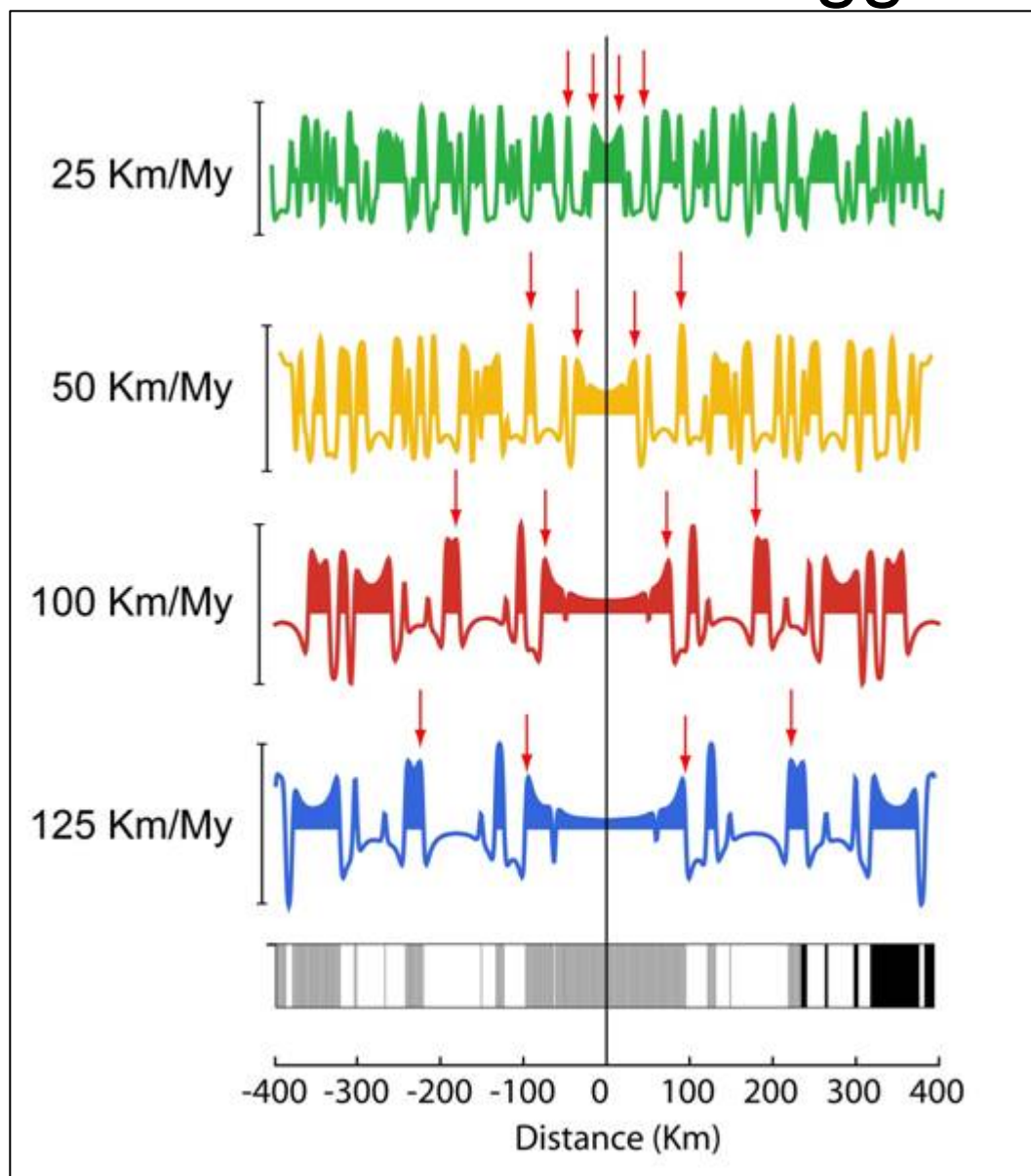


Sample Profiles across Mid-Ocean Ridges



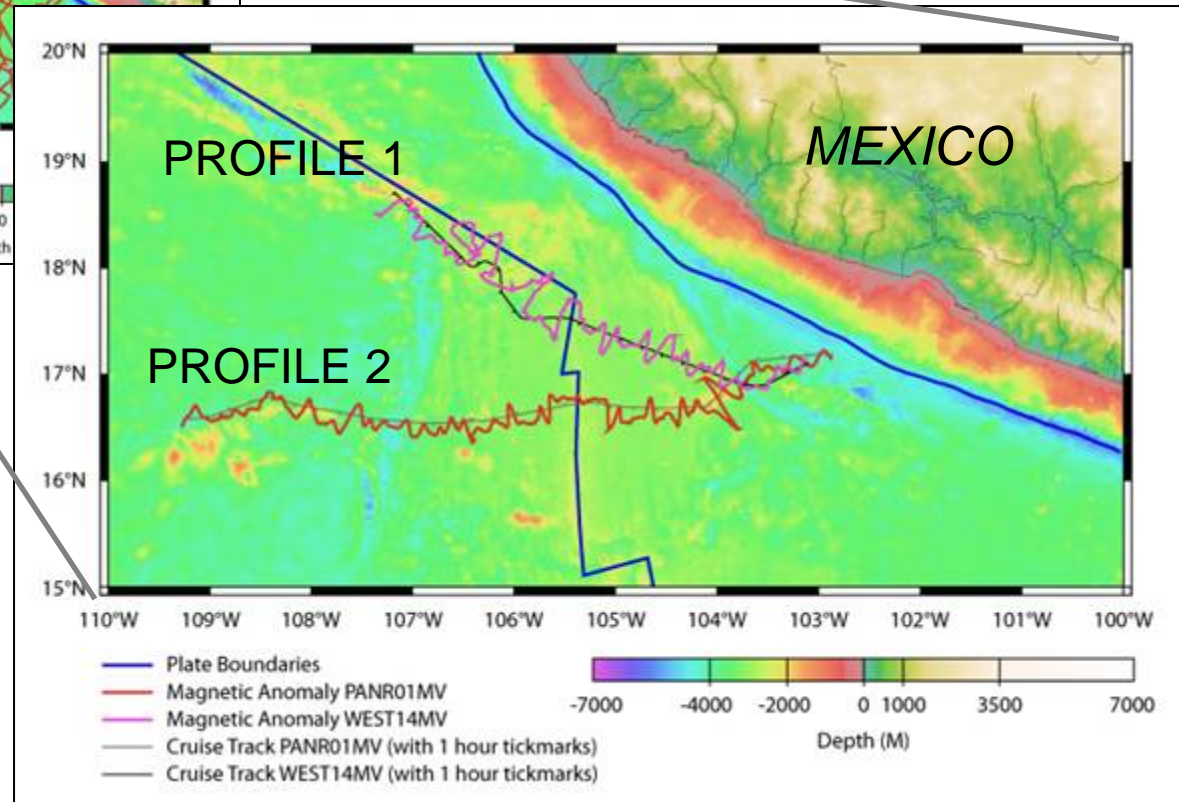
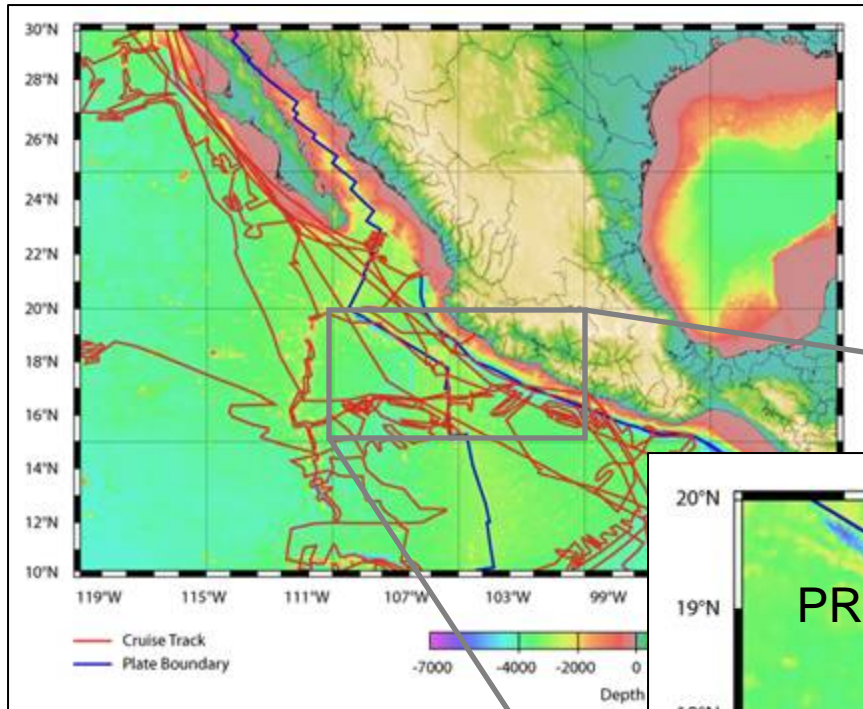


Changing Spreading Rate = Modified Wiggle Pattern





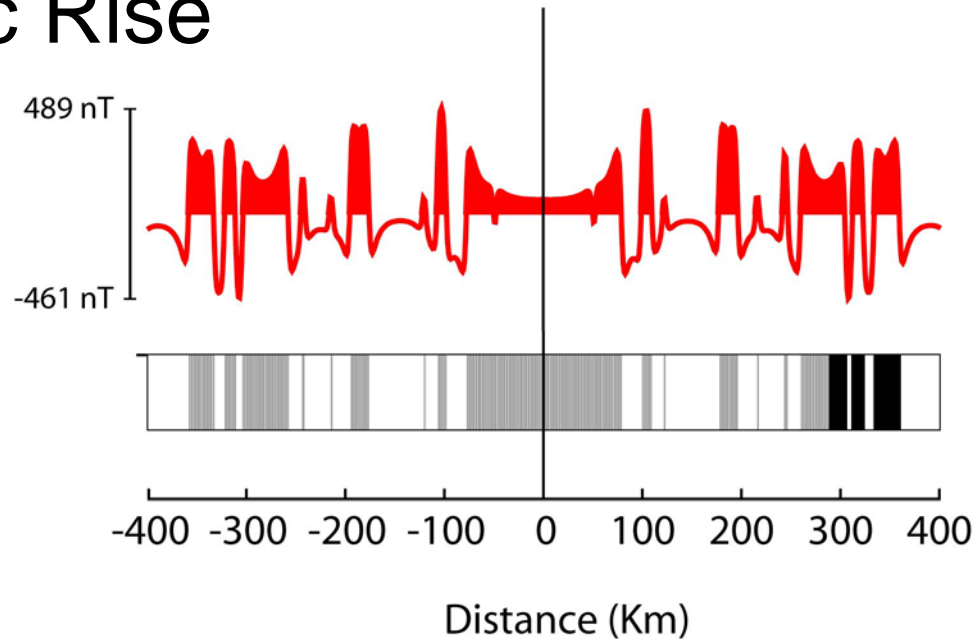
Shipboard Magnetic Data Across the EPR



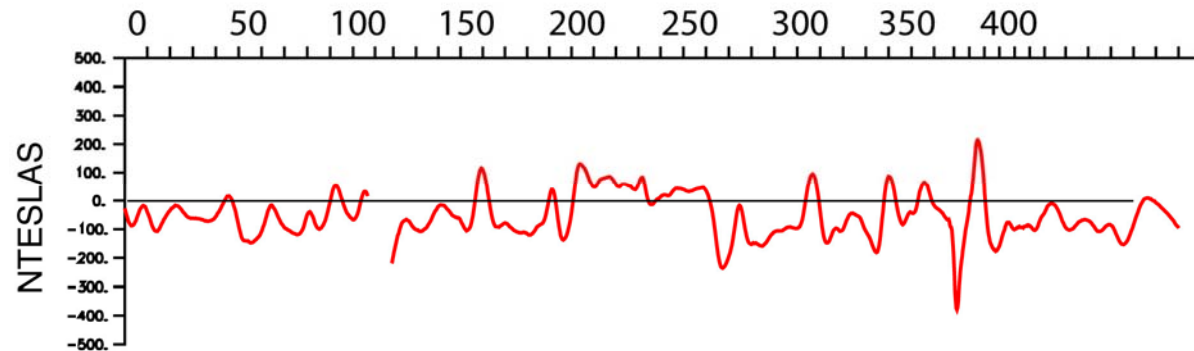
East Pacific Rise



MODEL



PROFILE 2

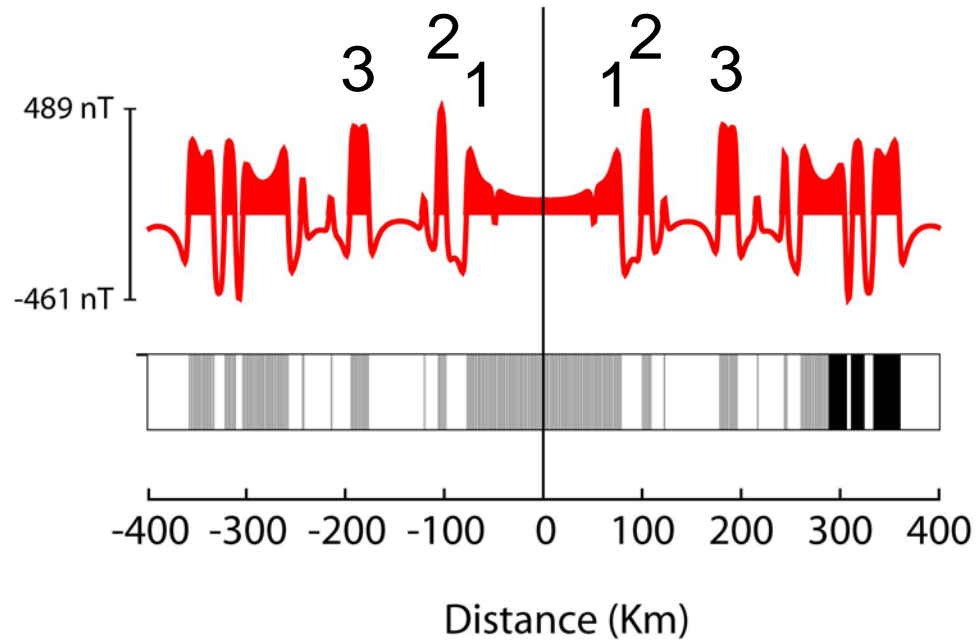


Using the marker, identify the location of the spreading ridge on PROFILE 2.

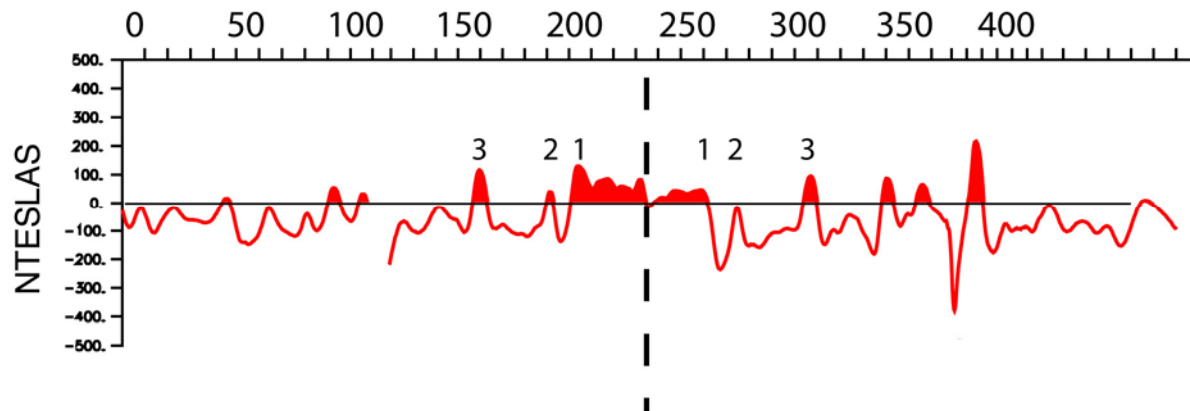
Solution - Matching Peaks



MODEL



PROFILE 2

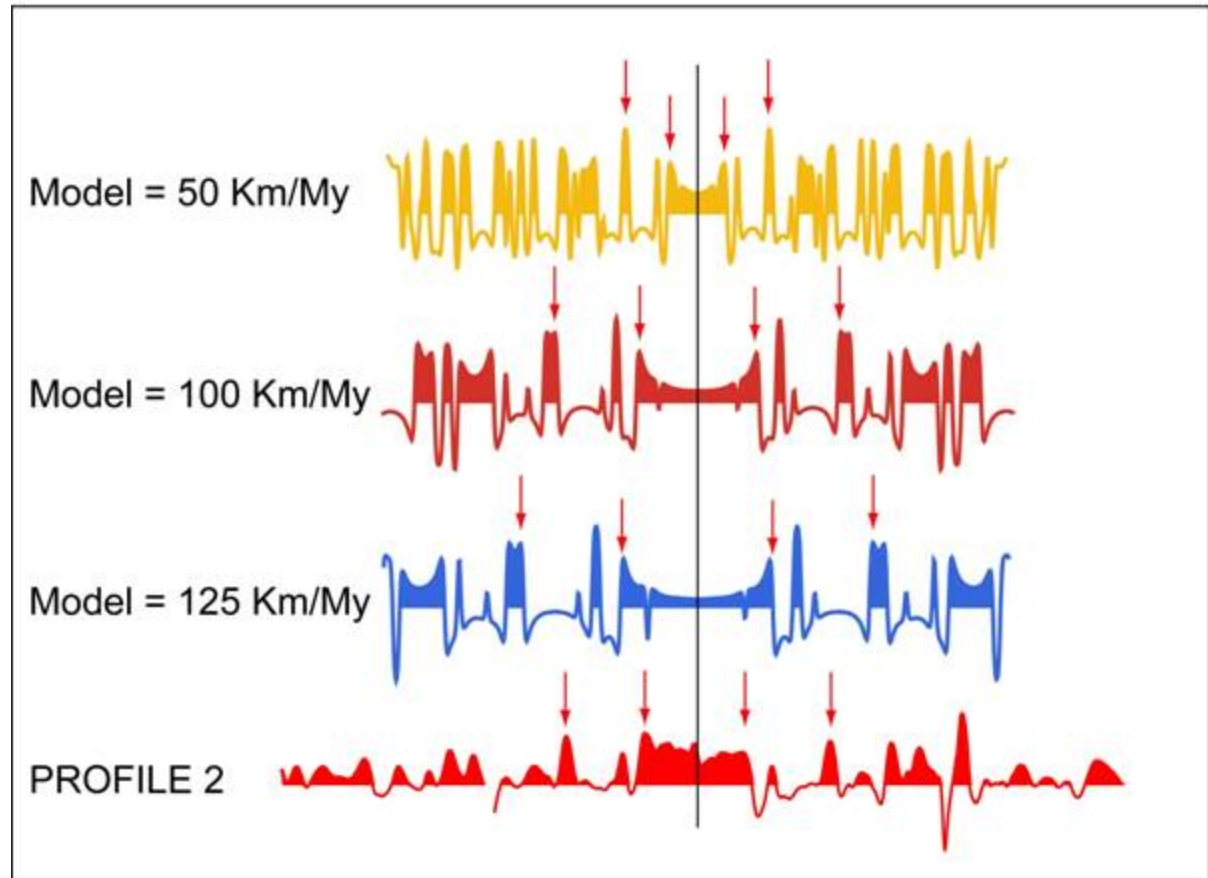


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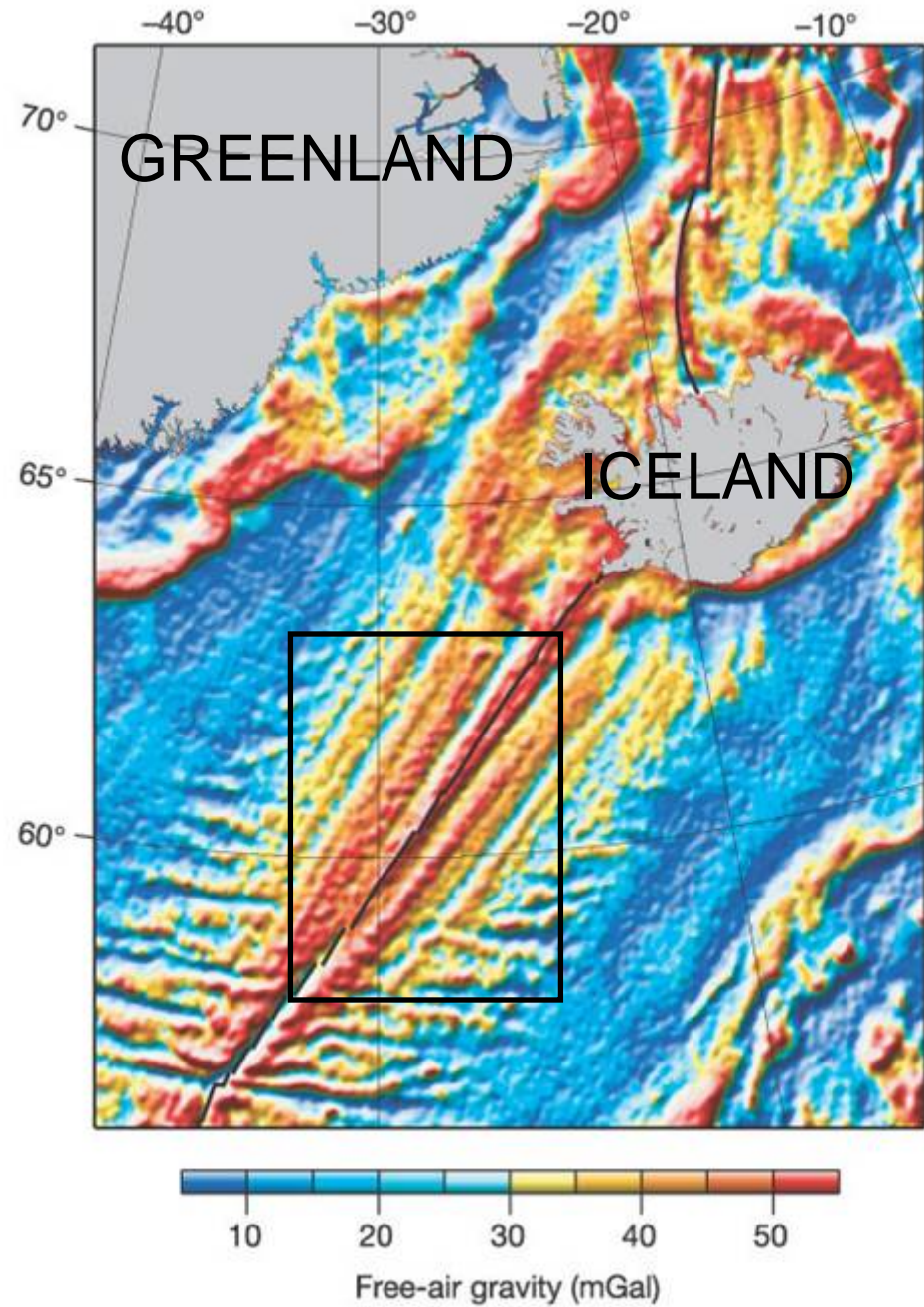
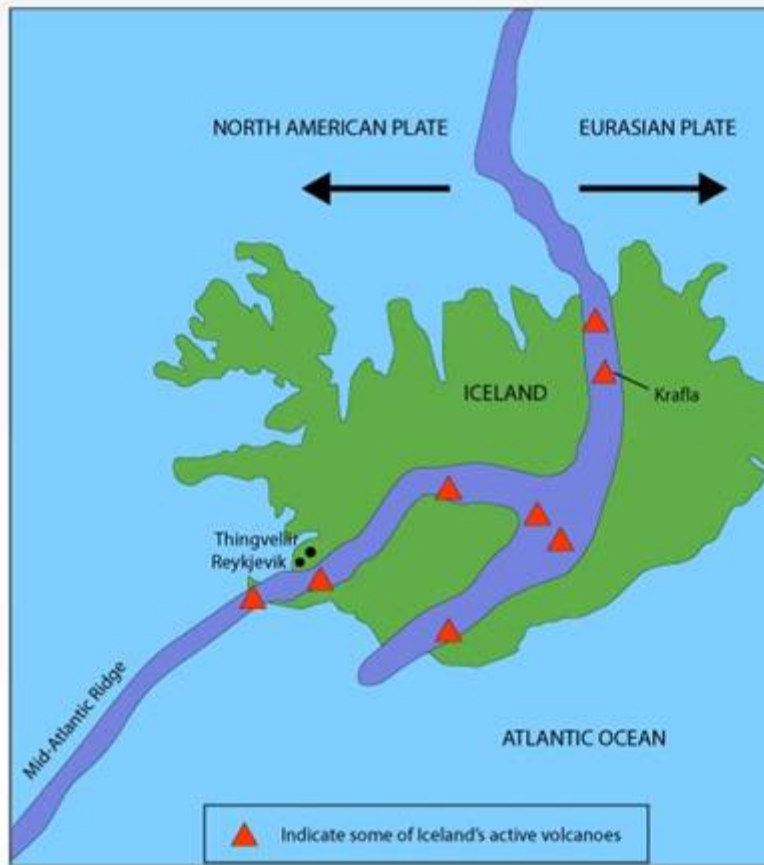


How fast is the East Pacific rise spreading?



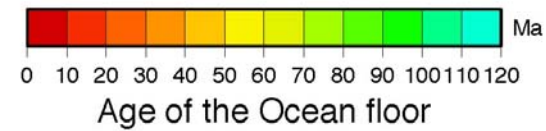
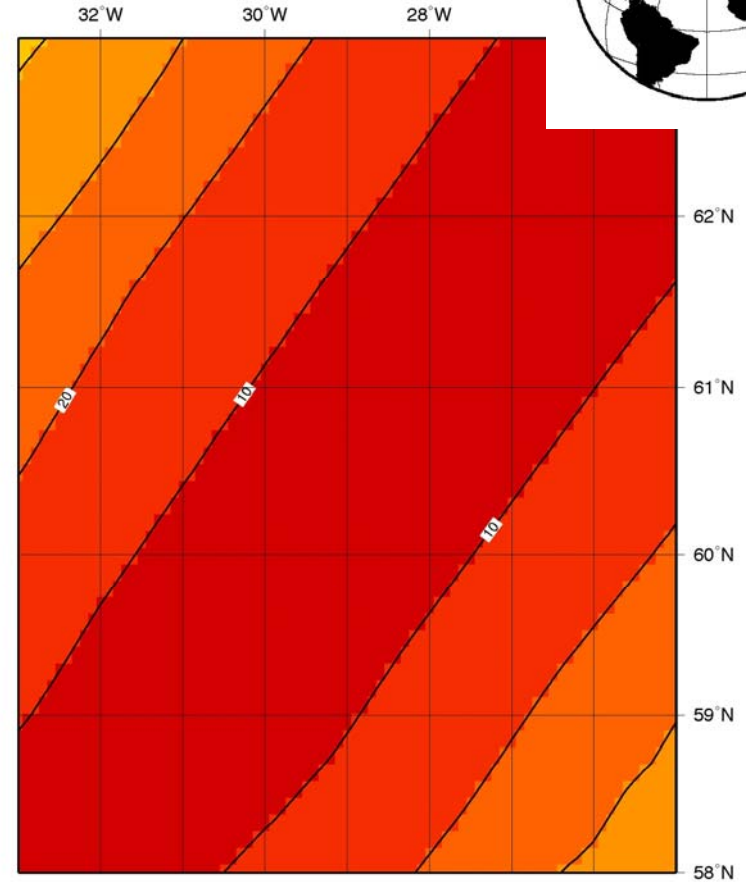
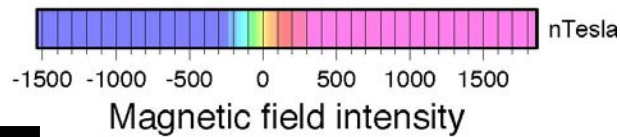
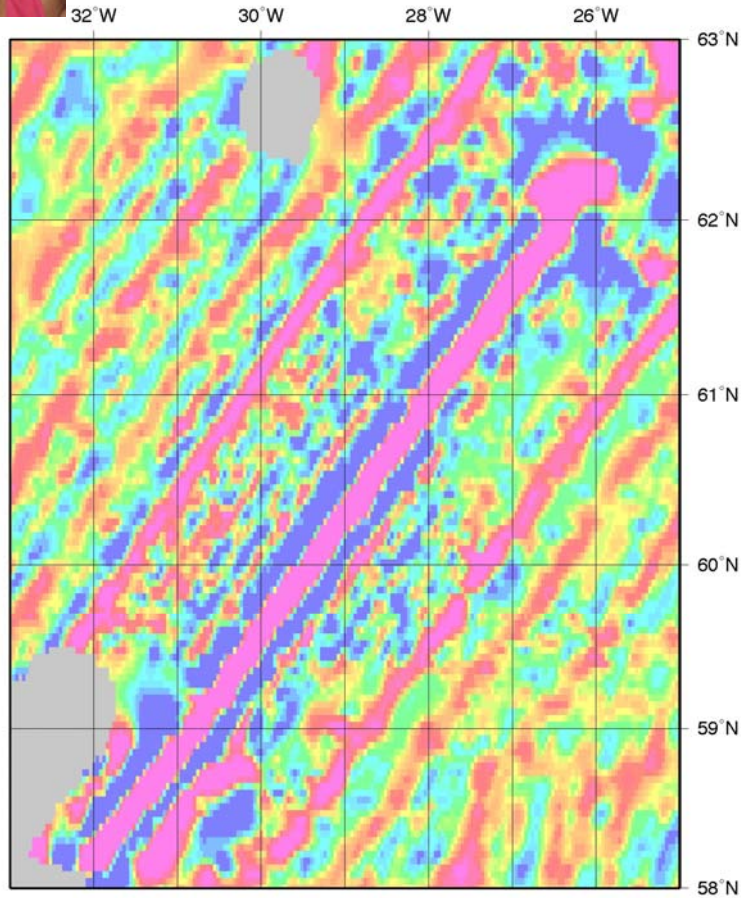
50 km/my	100 km/my	125 km/my

Mid-Atlantic Spreading Ridge





Data across Reykjanes Ridge



<http://nsdl.org>



What is the average spreading rate at the Reykjanes Ridge over the last 10 million years?

North American Plate

Eurasian Plate

Longitude (°W)	Latitude (°N)	Distance from Ridge (km)	Depth (m)	Sample Age (Ma)
32.70	60.86	-200	-2600	21.1
32.54	60.82	-190	-2588	19.9
32.37	60.78	-180	-2504	19.0
32.21	60.74	-170	-2465	17.9
32.05	60.70	-160	-2416	16.7
31.88	60.65	-150	-2401	15.7
31.72	60.61	-140	-2401	14.7
31.56	60.57	-130	-2328	13.7
31.40	60.53	-120	-2203	12.7
31.24	60.48	-110	-2103	11.4
31.08	60.44	-100	-1948	10.5
30.92	60.40	-90	-1832	9.4
30.76	60.35	-80	-1770	8.4
30.60	60.31	-70	-1657	7.5
30.44	60.27	-60	-1605	6.4
30.28	60.22	-50	-1599	5.4
30.13	60.18	-40	-1575	4.3
29.97	60.13	-30	-1473	3.2
29.81	60.09	-20	-1390	2.1
29.66	60.04	-10	-1169	1.2
29.50	60.00	0	-1011	0.2

Longitude (°W)	Latitude (°N)	Distance from Ridge (km)	Depth (m)	Sample Age (Ma)
29.50	60.00	0	-1011	0.2
29.34	59.95	10	-1108	0.8
29.19	59.91	20	-1272	2.1
29.04	59.86	30	-1410	3.2
28.88	59.82	40	-1549	4.4
28.73	59.77	50	-1415	5.6
28.57	59.73	60	-1529	6.6
28.42	59.68	70	-1668	7.7
28.27	59.63	80	-1797	8.8
28.12	59.59	90	-1848	9.9
27.96	59.54	100	-2017	10.9
27.81	59.49	110	-2194	11.9
27.66	59.45	120	-2143	12.9
27.51	59.40	130	-2040	13.9
27.36	59.35	140	-2003	14.9
27.21	59.31	150	-2080	16.1
27.06	59.26	160	-2271	17.0
26.91	59.21	170	-2389	17.9
26.77	59.16	180	-2320	19.1
26.62	59.11	190	-2213	20.1
26.47	59.07	200	-2235	21.3

Stamp One:

1 km/my

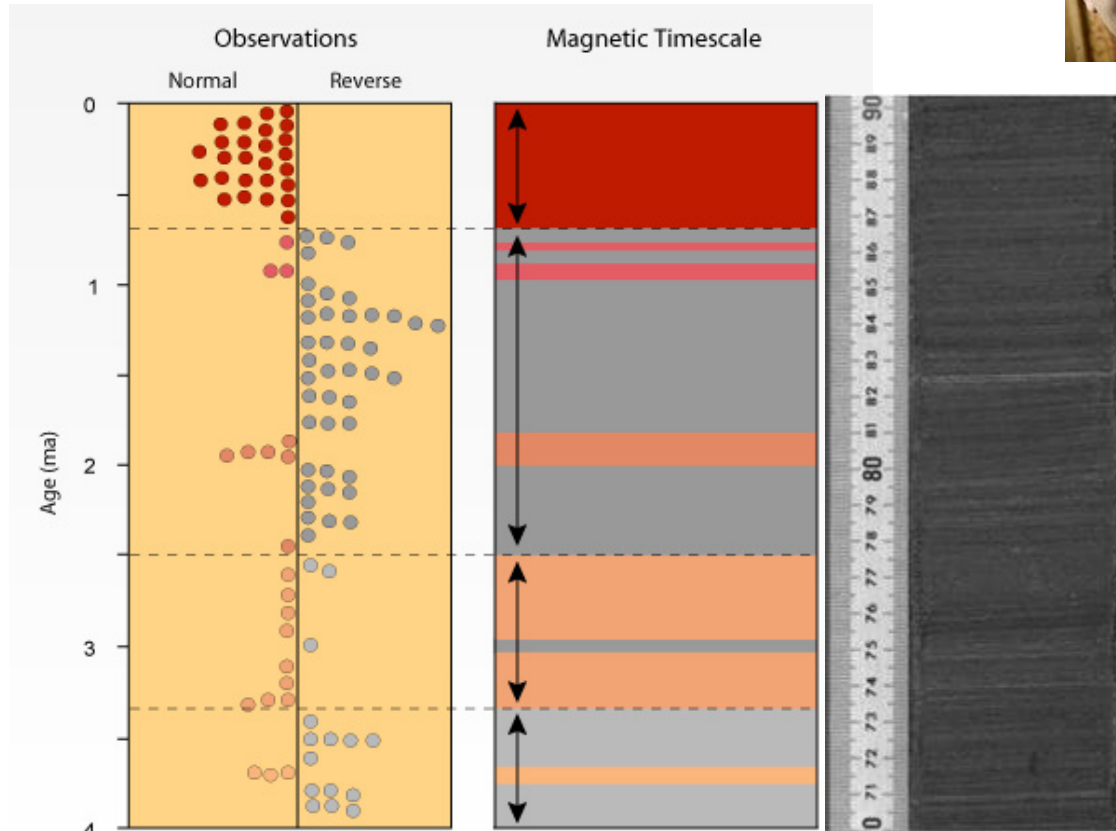
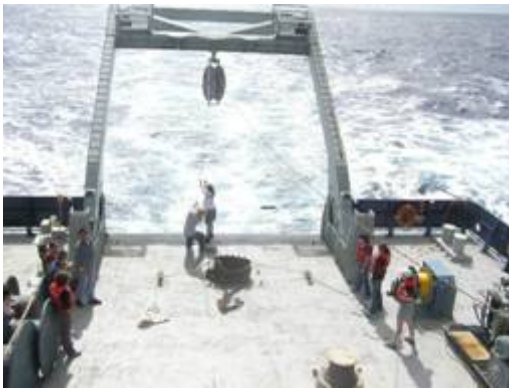
5 km/my

10 km/my



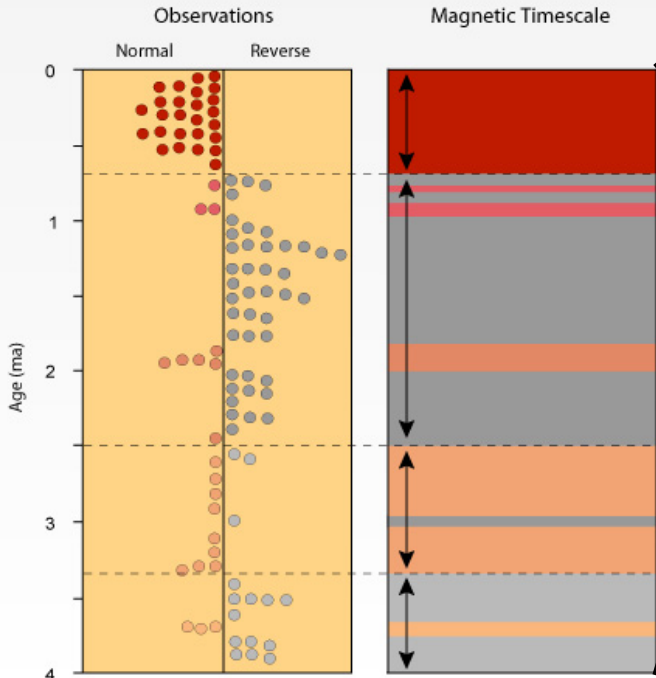
Let's pause for
two questions
from the
audience....

How old are the wiggles?





Time Scale



CENOZOIC						MESOZOIC											
AGE (Ma)	MAGNETIC POLARITY	PERIOD	EPOCH	AGE (Ma)	PICKS (Ma)	AGE (Ma)	MAGNETIC POLARITY	PERIOD	EPOCH	AGE (Ma)	PICKS (Ma)	UNCERT. (m.y.)					
0.01	1	QUATERNARY	HOLOCENE	0.01		65	30	CRETACEOUS	LATE	MAASTRICHTIAN	65	±2					
1.8	2	PLIOCENE	PLEISTOCENE	1.8		71.3	31			71.3	±1						
3.6	3		L	PIACENZIAN	3.6												
5.3	4		E	ZANCLEAN	5.3												
7.1	5	MIOCENE	MIOCENE	7.1		80	32			EARLY	CENOMANIAN	80	±1				
11.2	6			M	MESSINIAN	11.2						83.5	33	83.5	±1		
14.8	7			L	TORTONIAN	14.8						85.8	34	85.8	±1		
16.4	8			M	SERRAVALLIAN	16.4						89.0	35	89.0	±1		
20.5	9			E	LANGHIAN	20.5						93.5	36	93.5	±4		
23.8	10	OLIGOCENE	OLIGOCENE	23.8		99.0	37			NEOCOMIAN	ALBIAN	99.0	±1				
28.5	11			L	BURDIGALIAN	28.5		112	38			112	±2				
28.5	12			E	AQUITANIAN	28.5		121	39			121	±3				
33.7	13			L	CHATTIAN	33.7		127	40			127	±3				
37.0	14			E	RUPELIAN	37.0		132	41			132	±4				
41.3	15			EOCENE	EOCENE	41.3		137	42			MIDDLE	BAJOCIAN	137	±4		
49.0	16					L	PRIABONIAN	49.0						144	43	144	±5
54.8	17					M	BARTONIAN	54.8						151	44	151	±6
57.9	18					E	LUTETIAN	57.9						154	45	154	±7
61.0	19					L	YPRESIAN	61.0						159	46	159	±7
65.0	20	PALEOCENE	PALEOCENE	65.0		164	47	EARLY	TOARCIAN	164	±8						
	21			E	DANIAN					169	48	169	±8				
	22			L	SELANDIAN					176	49	176	±8				
	23			E	THANETIAN					180	50	180	±8				
	24			M	LUTETIAN					190	51	190	±8				
	25			E	YPRESIAN					195	52	195	±8				
	26			L	SELANDIAN					202	53	202	±8				
	27			E	DANIAN					206	54	206	±8				
	28			M	LUTETIAN					210	55	210	±8				
	29			E	YPRESIAN					221	56	221	±9				
	30	L	SELANDIAN			227	57	227	±9								
	31	E	DANIAN			234	58	234	±9								
	32	M	LUTETIAN			242	59	242	±9								
	33	E	YPRESIAN			245	60	245	±9								
	34	L	SELANDIAN			248	61	248	±10								



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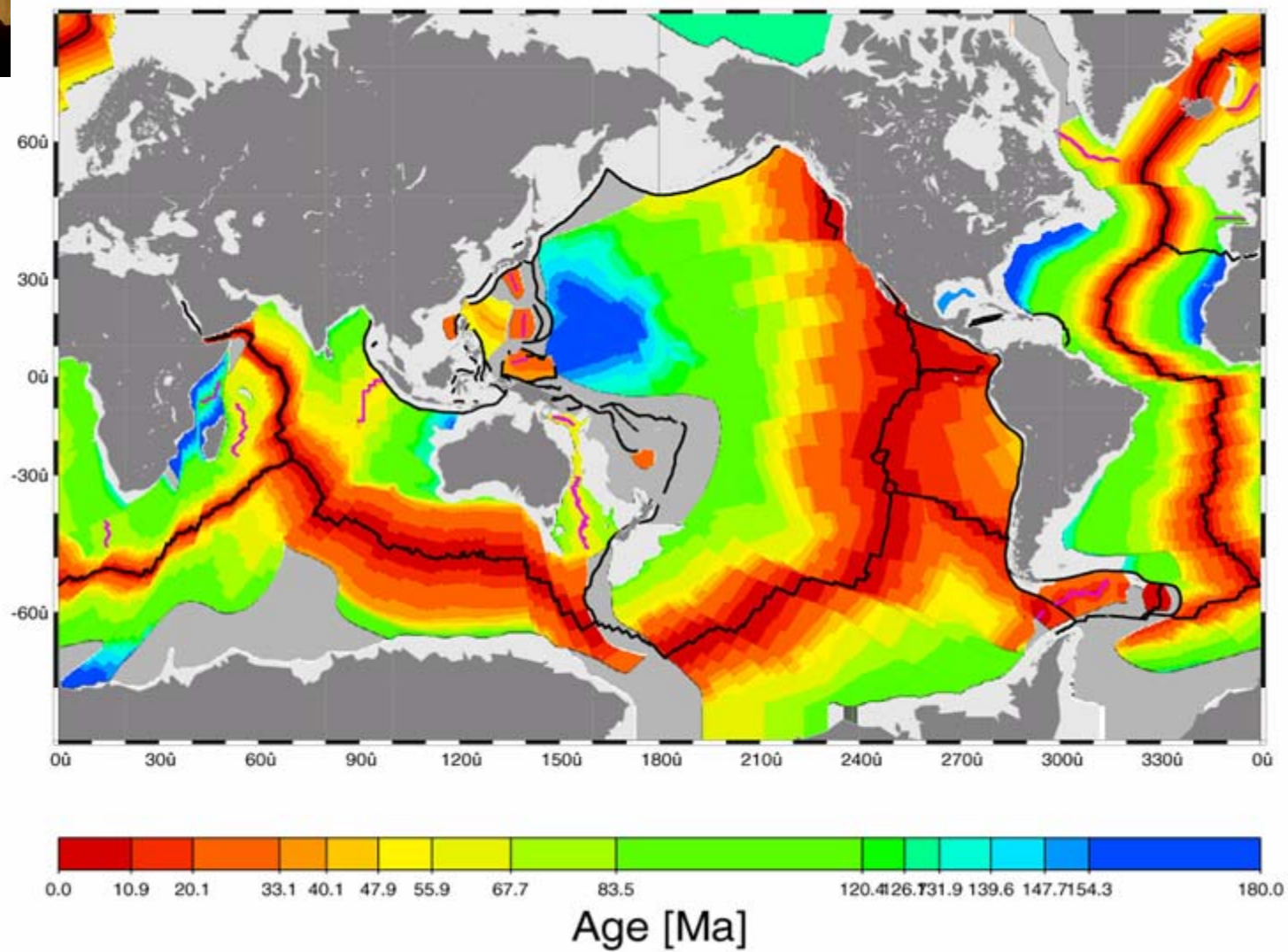


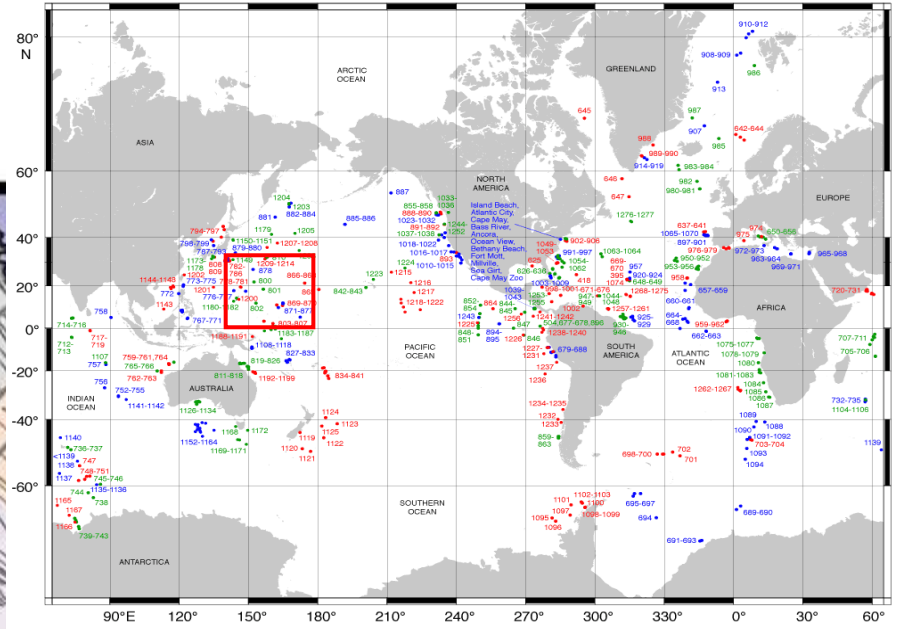
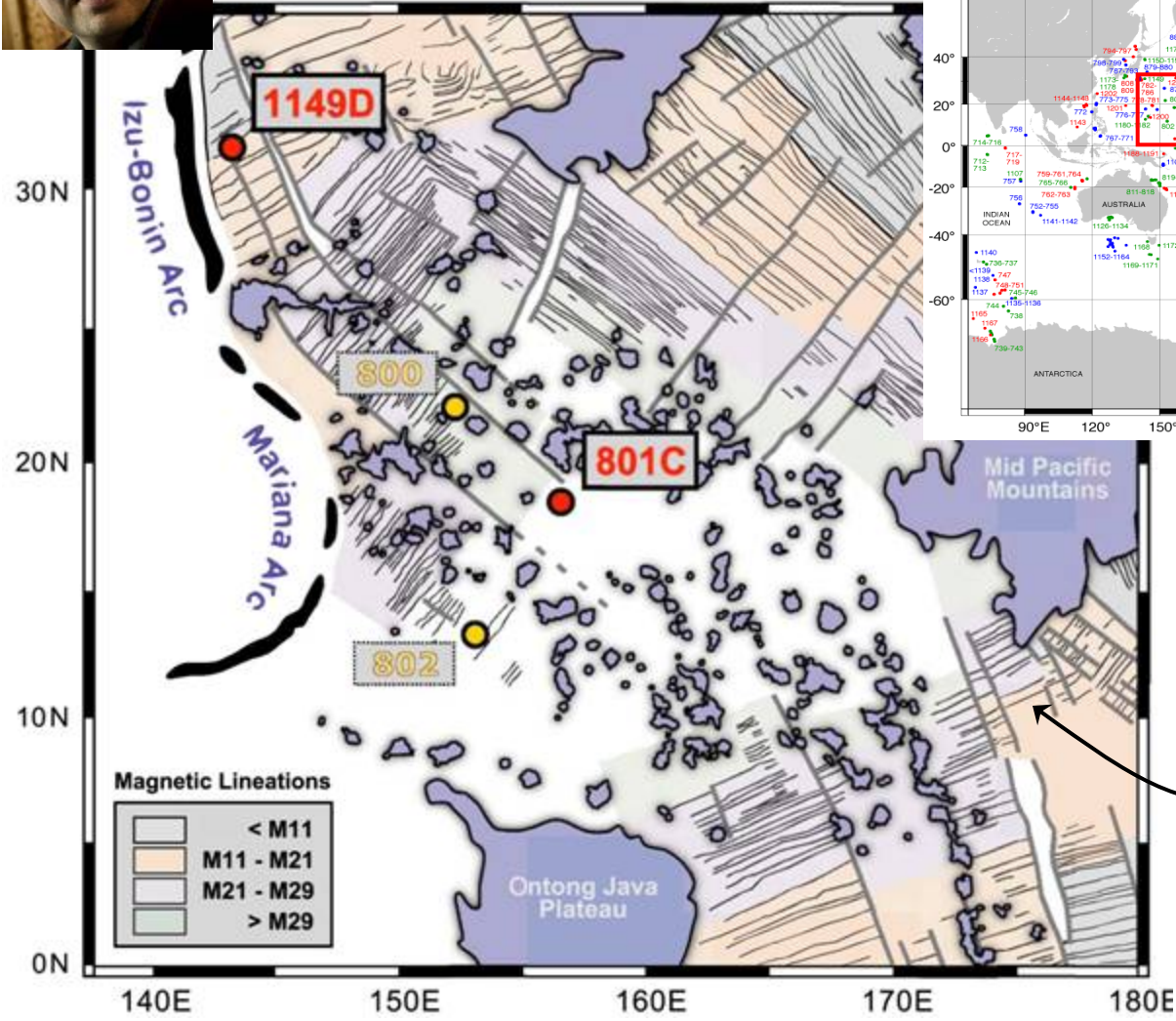
EXTREME AGES

- Age of the Earth ~ 4.6 Billion Years
- Oldest Rock ~ 3.5 Billion Years
- Oldest Mineral ~ 3.0 Billions Years
- Oldest Seafloor ~ xxx ???



Seafloor Age Map





Dating
OLDEST
Seafloor



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Ocean Drilling Program 1983-2003

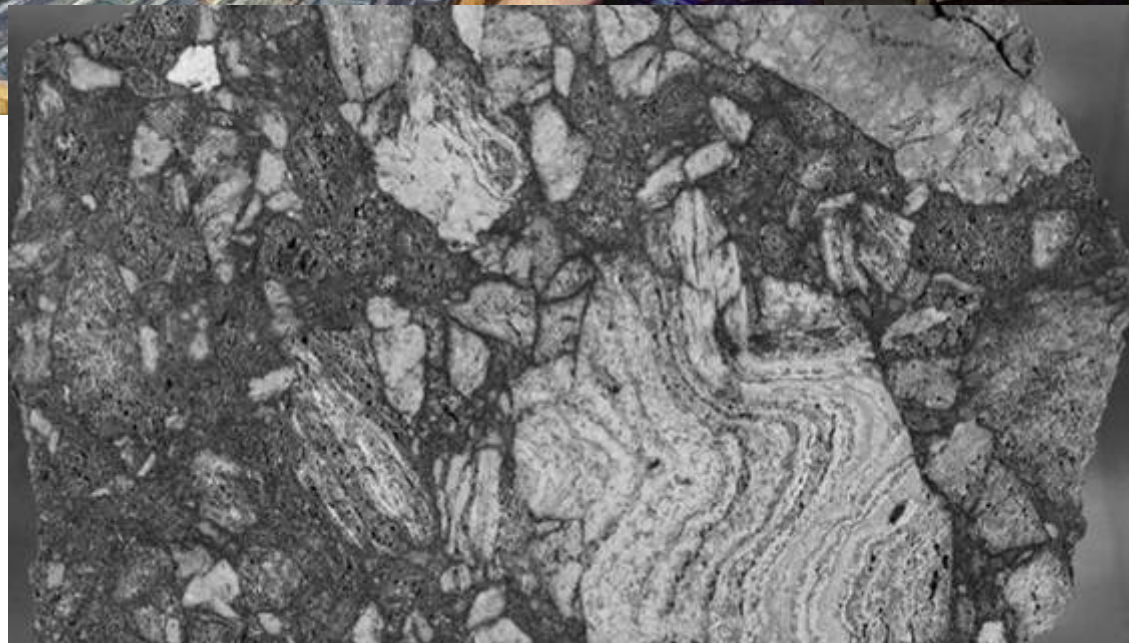
<http://www.odplegacy.org/>



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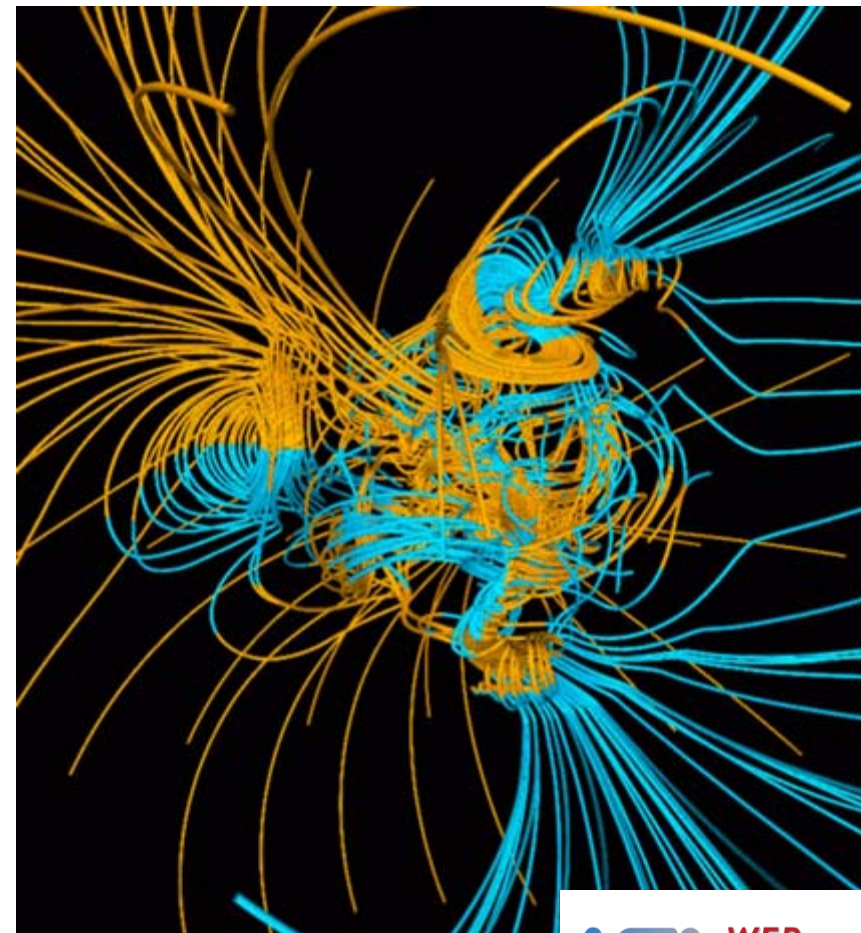
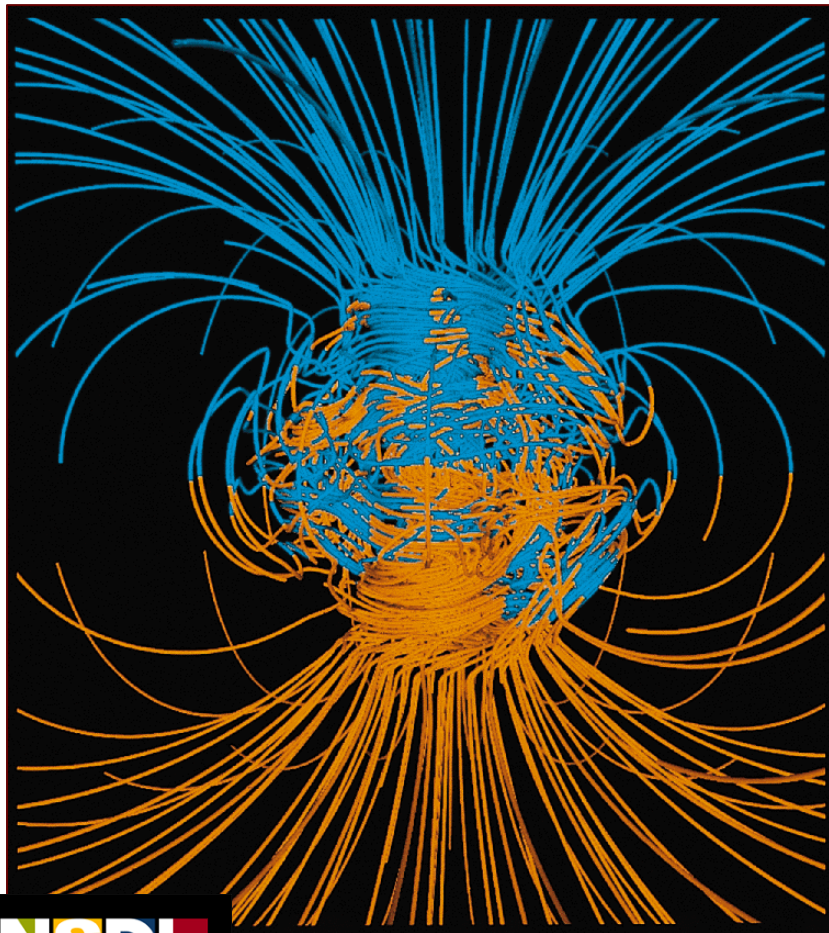
From seafloor to analysis to storage.....





Unsolved Mysteries

- Why does the Earth's magnetic field reverse?
- WHEN will be the next reversal?





Dr. Chris Massell Symons

csymons@ucsd.edu

**THANK
YOU!**



Dr. Anthony Koppers

akoppers@coas.oregonstate.edu

<http://earthref.org/ERESE>



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