

## **DIVERGENT PLATE BOUNDARIES AND THE HISTORY OF NORTHERN ATLANTIC SEA-FLOOR SPREADING**

You are provided with a map of magnetic anomalies in the north Atlantic region, and a copy of the magnetic anomaly time scale. On the map each individual anomaly, that is, each reversal of the earth's magnetic field, is given a consecutive number increasing back from the present and is represented as a single line. The age of each numbered anomaly is shown on the geologic time scale. Your goal is interpret the magnetic anomaly pattern in terms of the history of divergent plate motion between the North American and European plates across the mid-Atlantic ridge. Remember that anomalies are parallel to the ridge that made them, and are symmetric about the ridge that made them.

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1) First, study the anomaly pattern between Nova Scotia and Spain (south of the "Charlie Gibbs Fault Zone"). All the anomalies in this region are parallel to the present mid-Atlantic ridge, demonstrating that there has been continuous production of magnetic anomalies (and thus ocean crust) along this segment of the plate boundary since Anomaly 33 time (the oldest anomaly identified in this region. How long a time period has that been in millions of years?

2) Now consider the North Atlantic in the area between Labrador, Greenland, Iceland, and England, north of the "Charlie Gibbs Fault Zone". Use the distribution of magnetic anomalies to reconstruct the history of the divergent plate boundaries at which those anomalies were made.

a) Locate the modern divergent boundary north of the Charlie Gibbs transform and south of Iceland by drawing a colored line along the boundary.

What is the number of the oldest anomaly produced by that spreading center? (That is, what is the oldest anomaly that is parallel to the present ridge on both the east and the west sides of the ridge?)

What plate is Greenland on today?

b) Trace out the position of all Anomalies 20 and 24 with lines of a new color. This will show the location and shape of divergent boundaries during that time period.

Does this differ from the location and shape of divergent boundaries active in the area today?

How many divergent boundaries were present?

List each divergent boundary by listing the pair of plates on either side of that boundary.

What plate was Greenland on in Anomaly 24 time?

c) Now determine what plate boundary or boundaries were active north of the Charlie Gibbs transform from Anomaly 31 time to Anomaly 25 time. Again, trace out all positions of Anomaly 31 with colored lines to see where the divergent plate boundary would have been at that time.

How many divergent boundaries were present at Anomaly 31 time?

List each divergent boundary by listing the pair of plates on either side of that boundary.

What plate was Greenland on from Anomaly 31 to Anomaly 25 time?

3) Contrast your answers for Anomaly 31 time to those for Anomaly 24 time and for the present. Have the number of divergent plate boundaries and their location changed during the life of the North Atlantic ocean?

# DECADE OF NORTH AMERICAN GEOLOGY GEOLOGIC TIME SCALE



GEOLOGICAL SOCIETY  
OF AMERICA



DNAG

CENOZOIC										MESOZOIC										PALEOZOIC										PRECAMBRIAN			
AGE (Ma)	MAGNETIC POLARITY	PERIOD	EPOCH	AGE (Ma)	PICKS (Ma)	AGE (Ma)	PERIOD	EPOCH	AGE (Ma)	PICKS (Ma)	PERIOD	EPOCH	AGE (Ma)	PICKS (Ma)	PERIOD	EPOCH	AGE (Ma)	PICKS (Ma)	PERIOD	EPOCH	AGE (Ma)	PICKS (Ma)	PERIOD	EPOCH	ERA	EON	AGE (Ma)	BDY AGES (Ma)					
1	1	QUATERNARY	HOLOCENE	0.01		70	CRETACEOUS	LATE	66.4	245	PERMIAN	LATE	245	245	PERMIAN	LATE	245	245	PERMIAN	LATE	245	245	PERMIAN	LATE	LATE	PROTEROZOIC	570						
2	2	PLIOCENE	PLIOCENE	1.6		75	CRETACEOUS	LATE	74.5	253	MAASTRICHTIAN	LATE	74.5	253	PERMIAN	LATE	253	253	PERMIAN	LATE	253	253	PERMIAN	LATE	LATE	PROTEROZOIC	750						
3	3	ZANCLEAN	PLIOCENE	3.4		80	CRETACEOUS	LATE	84.0	258	CAMPANIAN	LATE	84.0	258	PERMIAN	LATE	258	258	PERMIAN	LATE	258	258	PERMIAN	LATE	LATE	PROTEROZOIC	900						
4	4	MESSINIAN	PLIOCENE	5.3		85	CRETACEOUS	LATE	87.5	263	SANTONIAN	LATE	87.5	263	PERMIAN	LATE	263	263	PERMIAN	LATE	263	263	PERMIAN	LATE	LATE	PROTEROZOIC	1000						
5	5		PLIOCENE	6.5		90	CRETACEOUS	LATE	88.5	268	CONIACIAN	LATE	88.5	268	PERMIAN	LATE	268	268	PERMIAN	LATE	268	268	PERMIAN	LATE	LATE	PROTEROZOIC	1250						
10	10		PLIOCENE	11.2		95	CRETACEOUS	LATE	91	286	TURONIAN	LATE	91	286	PERMIAN	LATE	286	286	PERMIAN	LATE	286	286	PERMIAN	LATE	LATE	PROTEROZOIC	1500						
15	15		PLIOCENE	15.1		100	CRETACEOUS	LATE	97.5	296	CENOMANIAN	LATE	97.5	296	PERMIAN	LATE	296	296	PERMIAN	LATE	296	296	PERMIAN	LATE	LATE	PROTEROZOIC	1750						
20	20		PLIOCENE	16.6		110	CRETACEOUS	LATE	113	315	ALBIAN	LATE	113	315	PERMIAN	LATE	315	315	PERMIAN	LATE	315	315	PERMIAN	LATE	LATE	PROTEROZOIC	2000						
25	25		PLIOCENE	21.8		120	CRETACEOUS	LATE	119	320	APTIAN	LATE	119	320	PERMIAN	LATE	320	320	PERMIAN	LATE	320	320	PERMIAN	LATE	LATE	PROTEROZOIC	2250						
30	30		PLIOCENE	23.7		130	CRETACEOUS	LATE	124	333	BARREMIAN	LATE	124	333	PERMIAN	LATE	333	333	PERMIAN	LATE	333	333	PERMIAN	LATE	LATE	PROTEROZOIC	2500						
35	35		PLIOCENE	30.0		140	CRETACEOUS	LATE	131	352	HAUTERIVIAN	LATE	131	352	PERMIAN	LATE	352	352	PERMIAN	LATE	352	352	PERMIAN	LATE	LATE	PROTEROZOIC	2750						
40	40		PLIOCENE	36.6		150	CRETACEOUS	LATE	138	360	VALANGINIAN	LATE	138	360	PERMIAN	LATE	360	360	PERMIAN	LATE	360	360	PERMIAN	LATE	LATE	PROTEROZOIC	3000						
45	45		PLIOCENE	40.0		160	CRETACEOUS	LATE	144	367	BERRIASIAN	LATE	144	367	PERMIAN	LATE	367	367	PERMIAN	LATE	367	367	PERMIAN	LATE	LATE	PROTEROZOIC	3250						
50	50		PLIOCENE	43.6		170	CRETACEOUS	LATE	152	374	TITHONIAN	LATE	152	374	PERMIAN	LATE	374	374	PERMIAN	LATE	374	374	PERMIAN	LATE	LATE	PROTEROZOIC	3500						
55	55		PLIOCENE	52.0		180	CRETACEOUS	LATE	156	380	KIMMERIDGIAN	LATE	156	380	PERMIAN	LATE	380	380	PERMIAN	LATE	380	380	PERMIAN	LATE	LATE	PROTEROZOIC	3750						
60	60		PLIOCENE	57.8		190	CRETACEOUS	LATE	163	387	OXFORDIAN	LATE	163	387	PERMIAN	LATE	387	387	PERMIAN	LATE	387	387	PERMIAN	LATE	LATE	PROTEROZOIC	3800?						
65	65		PLIOCENE	60.6		200	CRETACEOUS	LATE	169	394	CALLOVIAN	LATE	169	394	PERMIAN	LATE	394	394	PERMIAN	LATE	394	394	PERMIAN	LATE	LATE	PROTEROZOIC							
29	29		PLIOCENE	63.6		210	CRETACEOUS	LATE	176	401	BATHONIAN	LATE	176	401	PERMIAN	LATE	401	401	PERMIAN	LATE	401	401	PERMIAN	LATE	LATE	PROTEROZOIC							
28	28		PLIOCENE	66.4		220	CRETACEOUS	LATE	183	408	BAJOCIAN	LATE	183	408	PERMIAN	LATE	408	408	PERMIAN	LATE	408	408	PERMIAN	LATE	LATE	PROTEROZOIC							
27	27		PLIOCENE			230	CRETACEOUS	LATE	187	414	AALENIAN	LATE	187	414	PERMIAN	LATE	414	414	PERMIAN	LATE	414	414	PERMIAN	LATE	LATE	PROTEROZOIC							
26	26		PLIOCENE			240	CRETACEOUS	LATE	193	421	TOARCIAN	LATE	193	421	PERMIAN	LATE	421	421	PERMIAN	LATE	421	421	PERMIAN	LATE	LATE	PROTEROZOIC							
25	25		PLIOCENE			250	CRETACEOUS	LATE	198	428	PLIENSCHACHIAN	LATE	198	428	PERMIAN	LATE	428	428	PERMIAN	LATE	428	428	PERMIAN	LATE	LATE	PROTEROZOIC							
24	24		PLIOCENE			260	CRETACEOUS	LATE	204	438	SINEMURIAN	LATE	204	438	PERMIAN	LATE	438	438	PERMIAN	LATE	438	438	PERMIAN	LATE	LATE	PROTEROZOIC							
23	23		PLIOCENE			270	CRETACEOUS	LATE	208	448	HETTANGIAN	LATE	208	448	PERMIAN	LATE	448	448	PERMIAN	LATE	448	448	PERMIAN	LATE	LATE	PROTEROZOIC							
22	22		PLIOCENE			280	CRETACEOUS	LATE	225	458	NORIAN	LATE	225	458	PERMIAN	LATE	458	458	PERMIAN	LATE	458	458	PERMIAN	LATE	LATE	PROTEROZOIC							
21	21		PLIOCENE			290	CRETACEOUS	LATE	230	468	CARNIAN	LATE	230	468	PERMIAN	LATE	468	468	PERMIAN	LATE	468	468	PERMIAN	LATE	LATE	PROTEROZOIC							
20	20		PLIOCENE			300	CRETACEOUS	LATE	235	478	LADINIAN	LATE	235	478	PERMIAN	LATE	478	478	PERMIAN	LATE	478	478	PERMIAN	LATE	LATE	PROTEROZOIC							
19	19		PLIOCENE			310	CRETACEOUS	LATE	240	488	ANISIAN	LATE	240	488	PERMIAN	LATE	488	488	PERMIAN	LATE	488	488	PERMIAN	LATE	LATE	PROTEROZOIC							
18	18		PLIOCENE			320	CRETACEOUS	LATE	245	505	SCYTHIAN	LATE	245	505	PERMIAN	LATE	505	505	PERMIAN	LATE	505	505	PERMIAN	LATE	LATE	PROTEROZOIC							
17	17		PLIOCENE			330	CRETACEOUS	LATE	250	523		LATE	250	523	PERMIAN	LATE	523	523	PERMIAN	LATE	523	523	PERMIAN	LATE	LATE	PROTEROZOIC							
16	16		PLIOCENE			340	CRETACEOUS	LATE	255	540		LATE	255	540	PERMIAN	LATE	540	540	PERMIAN	LATE	540	540	PERMIAN	LATE	LATE	PROTEROZOIC							
15	15		PLIOCENE			350	CRETACEOUS	LATE	260	550		LATE	260	550	PERMIAN	LATE	550	550	PERMIAN	LATE	550	550	PERMIAN	LATE	LATE	PROTEROZOIC							
14	14		PLIOCENE			360	CRETACEOUS	LATE	265	560		LATE	265	560	PERMIAN	LATE	560	560	PERMIAN	LATE	560	560	PERMIAN	LATE	LATE	PROTEROZOIC							
13	13		PLIOCENE			370	CRETACEOUS	LATE	270	570		LATE	270	570	PERMIAN	LATE	570	570	PERMIAN	LATE	570	570	PERMIAN	LATE	LATE	PROTEROZOIC							
12	12		PLIOCENE			380	CRETACEOUS	LATE	275	580		LATE	275	580	PERMIAN	LATE	580	580	PERMIAN	LATE	580	580	PERMIAN	LATE	LATE	PROTEROZOIC							
11	11		PLIOCENE			390	CRETACEOUS	LATE	280	590		LATE	280	590	PERMIAN	LATE	590	590	PERMIAN	LATE	590	590	PERMIAN	LATE	LATE	PROTEROZOIC							
10	10		PLIOCENE			400	CRETACEOUS	LATE	285	600		LATE	285	600	PERMIAN	LATE	600	600	PERMIAN	LATE	600	600	PERMIAN	LATE	LATE	PROTEROZOIC							
9	9		PLIOCENE			410	CRETACEOUS	LATE	290	610		LATE	290	610	PERMIAN	LATE	610	610	PERMIAN	LATE	610	610	PERMIAN	LATE	LATE	PROTEROZOIC							
8	8		PLIOCENE			420	CRETACEOUS	LATE	295	620		LATE	295	620	PERMIAN	LATE	620	620	PERMIAN	LATE	620	620	PERMIAN	LATE	LATE	PROTEROZOIC							
7	7		PLIOCENE			430	CRETACEOUS	LATE	300	630		LATE	300	630	PERMIAN	LATE	630	630	PERMIAN	LATE	630	630	PERMIAN	LATE	LATE	PROTEROZOIC							
6	6		PLIOCENE			440	CRETACEOUS	LATE	305	640		LATE	305	640	PERMIAN	LATE	640	640	PERMIAN	LATE	640	640	PERMIAN	LATE	LATE	PROTEROZOIC							
5	5		PLIOCENE			450	CRETACEOUS	LATE	310	650		LATE	310	650	PERMIAN	LATE	650	650	PERMIAN	LATE	650	650	PERMIAN	LATE	LATE	PROTEROZOIC							
4	4		PLIOCENE			460	CRETACEOUS	LATE	315	660		LATE	315	660	PERMIAN	LATE	660	660	PERMIAN	LATE	660	660	PERMIAN	LATE	LATE	PROTEROZOIC							
3	3		PLIOCENE			470	CRETACEOUS	LATE	320	670		LATE	320	670	PERMIAN	LATE	670	670	PERMIAN	LATE	670	670	PERMIAN	LATE	LATE	PROTEROZOIC							
2	2		PLIOCENE			480	CRETACEOUS	LATE	325	680		LATE	325	680	PERMIAN	LATE	680	680	PERMIAN	LATE	680	680	PERMIAN	LATE	LATE	PROTEROZOIC							
1	1		PLIOCENE			490	CRETACEOUS	LATE	330	690		LATE	330	690	PERMIAN	LATE	690	690	PERMIAN	LATE	690	690	PERMIAN	LATE	LATE	PROTEROZOIC							

