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## WHAT BIOSTRATIGRAPHIC CONTINUITY SUGGESTS ABOUT EARTH HISTORY

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### ABSTRACT

The number of local, stage boundary-straddling species (NLSSS) at each stage-stage boundary is determined from the Paleobiology Database. The pattern of NLSSS values qualitatively defines five biostratigraphic zones: the Precambrian through Cambrian (with zero to low NLSSS values), the Ordovician through Mississippian (with low to moderate NLSSS values), the Pennsylvanian through Permian (with very high NLSSS values), the Mesozoic (with low to high NLSSS values), and the Cenozoic (with moderate to very high NLSSS values).

As a criterion for identifying the pre-Flood/Flood boundary, NLSSS values strongly suggest a position below the Ordovician. As a criterion for identifying the Flood/post-Flood boundary, NLSSS values strongly argue against a position very much above the Cretaceous/Paleogene boundary. The Cretaceous/Paleogene boundary is suggested by terrestrial NLSSS values in North America, but a definitive global argument must await re-evaluation of global terrestrial vs. marine NLSSS data. Tentatively then, the bottom and top NLSSS biostratigraphic zones are designated pre-Flood and post-Flood, respectively. The middle three NLSSS biostratigraphic zones—tentatively interpreted as Flood sediments—are provisionally identified as the burial of dominantly marine, coastline, and terrestrial organisms, respectively.

The large—and possibly periodic—variations in NLSSS values suggest that further mining of paleontological data may reveal interesting biogeographical and/or depositional processes during pre-Flood, Flood, and post-Flood times. Lack of correlation between NLSSS pattern and stage-through-system-level biostratigraphic zones suggests that index fossils and sub-erathem stratigraphic units provide no more information about earth history than a relative time scale. Lack of NLSSS/megasequence correlations also suggests that surges in Flood energy were largely independent of the depositional pattern of fossils.

### KEYWORDS

pre-Flood, Flood, post-Flood, paleontology, biostratigraphy, boundary criterion.

### INTRODUCTION

Fossils—as evidence of organisms living in the past—played an important part in diluvial theory, even before the rise of modern creationism (see, e.g., Nelson 1931). Fossils were also important in many of the publications of early twentieth century creationists like George McCready Price (see, e.g., Wise 2018), and they are referred to throughout the seminal creationist work, *The Genesis Flood* (Whitcomb and Morris 1961). Since then, there is scarcely an issue of any creationist journal that does not have at least one article referring to fossils.

Creationism also has an interest in global patterns (such as those patterns that might identify and characterize the global Flood). Yet, in spite of the importance of fossils, and the emphasis in global patterns, creationists have made little use of the Paleobiology Database (PBDB). The PBDB is a repository of data on fossils from all globally defined stratigraphic levels, and from localities all over the world. Although the PBDB is still in development, it already contains data from millions of fossils from all over the world. We agree with Ross's (2012, 2013, 2014a, 2014b) arguments for the reliability of PBDB data. We would like to encourage the use and mining of PBDB data by creationists by offering one example of the use of PBDB data in

the development of creationist Flood models.

In particular, we would like to use the PBDB to examine the persistence of biological form through the stratigraphic record—what we call biostratigraphic continuity. Scientists have used various forms of biostratigraphic continuity—and discontinuity—for as long as paleontology has been a discipline. In the nineteenth and twentieth centuries, global biostratigraphic discontinuity was used to argue for biological extinction and mass extinction, as well as define the biostratigraphic column. Biostratigraphic continuity at particular taxonomic levels has been used to argue for everything from species stasis (e.g., Eldredge and Gould 1972) to class-level evolutionary faunas (Sepkoski 1981). In creationism, biostratigraphic continuity has been used to argue both for biological change (Wood et al. 2003) and against biological change (e.g., Scheven 1990). Biostratigraphic discontinuity has been used to identify the pre-Flood/Flood boundary (e.g., Austin and Wise 1994), and the Flood/post-Flood boundary (e.g., Ross 2012). For these reasons, we believe biostratigraphic continuity—especially global biostratigraphic continuity—has great potential in providing creationist insight into earth history. In this paper, then, we will extract biostratigraphic continuity data from the PBDB. Since multiple measures of biostratigraphic continuity are possible, and we will only use one in this paper, we believe this could

be the beginning of a large research program.

## METHODS

For our measure of biostratigraphic continuity, we have chosen to define it at the finest scale possible from PBDB data. This is because finer-scale data typically leads to clearer understanding, and more convincing conclusions. Future research can use coarser-scale data in those cases where the finest scale data are unavailable or unsatisfactorily rare. Biostratigraphic continuity is indicated when a particular taxon is found in two successive stratigraphic units within a particular geographic area. Thus biostratigraphic continuity uses taxonomic, stratigraphic, and geographic data. Since the finest-scale taxonomic identification of the greatest majority of PBDB fossils is the species, we use a species-level biostratigraphic continuity measure. Since the stage is the finest-scale global stratigraphic unit reported for the vast majority of Phanerozoic PBDB fossils, we also use a stage-level stratigraphic continuity measure in the Phanerozoic. In the case of Proterozoic and Archean fossils, the PBDB's finest global stratigraphic resolution is the system and erathem, respectively. Thus the stratigraphic scales we use in the Archean and Proterozoic are the erathem and system, respectively. Requiring a taxon to be found in both the stratigraphic unit immediately below and above the boundary is a further refinement of scale for it omits taxa that are not found right up against the boundary. Finally, the PBDB reports fossil location with GPS coordinates and an estimate of GPS precision. Since the precision is most often given in qualitative terms (e.g., 'minutes' or 'seconds'), an 'average' precision can only be estimated roughly, but it seems to be between 1 and 2 degrees of latitude and longitude. Thus, we use a biostratigraphic continuity measure of two degrees latitude and longitude. Our paleontological continuity measure, then, for the Phanerozoic is the number of species reported in both the stage below and the stage above a particular stage-stage boundary within 2 degrees longitude and latitude. We use the same measure for Archean and Proterozoic fossils, substituting (in place of stage) erathem and system, respectively. We call this the Number of Local, Stage boundary-Straddling Species (NLSSS).

We determined the NLSSS for the 100 stage-stage boundaries of the Phanerozoic, the 10 system-system boundaries of the Proterozoic, and the 4 erathem-erathem boundaries of the Archean. For each boundary, we downloaded two files from the Paleobiology Database (PBDB; paleobiodb.org)—one for all the taxa reported in the global stratigraphic unit immediately below the boundary and one for all the taxa reported in the global stratigraphic unit immediately above the boundary. Each of these files was processed to the taxonomic level of species by deleting all records identified less precisely than the species level, and considering only at the species level those records identified more precisely than the species level. Each file was also processed to the proper stratigraphic level by deleting all records that located the fossil less precisely than the Phanerozoic stage (or Proterozoic system or Archean erathem). Some of the biostratigraphic data of the PBDB is given in regionally-defined stages, as opposed to globally-defined stages. Desiring to include as much data as possible, we accepted a regional stage boundary as equivalent to a globally-defined stage boundary when the radiometric ages of those boundaries was less than two million radiometric years apart. Given the fact that radiometric years are most probably an extreme exag-

geration of real years, a difference of two million radiometric years is here considered small enough to suggest they are more or less simultaneous boundaries, even though they are found at different places on the earth. The average stage length through the Phanerozoic was 10.4 million radiometric years. The two million years was an arbitrary value less than one quarter that average stage length. We set this criterion less in the case of boundaries atop stages less than two million radiometric years long. For the two uppermost stage-stage boundaries, this criterion was set to zero, and for the remaining short stages, this criterion was set to one million radiometric years.

Then, for each of the 114 globally-defined stratigraphic boundaries, the two files (the file with species below the boundary and the file with species above the boundary) were combined into a single file. From that file, all records were deleted for species found only on one side of the boundary. Then, for each species in that file, all records were deleted that were located more than two degrees latitude or longitude (greater than about 200-300 miles) from all other occurrences on the opposite side of the boundary. The records remaining in this file, then, are all records of species found on both sides of the boundary within two degrees longitude and latitude. The count of how many different species are found in this final file is the NLSSS for this stratigraphic boundary.

## RESULTS

The results are given in Table 1. For brevity in referring to particular stratigraphic boundaries, each of the 114 stratigraphic boundaries was assigned a number from 1 for the oldest boundary to 114 for the most recent boundary (column A). For each boundary, the number of different species reported in the PBDB from the globally-defined stratigraphic unit below the boundary is given in column B, and the NLSSS for that boundary is given in column C. The percentage of species in the stratigraphic unit below that boundary that straddle the boundary is given in column F (as %NLSSS). Columns C and F are graphed in Figure 1.

The results of our analysis are robust with respect to the most arbitrary decisions we made in our analysis. First, to include as many local biostratigraphic units as possible, we equated them with the closest global stratigraphic unit if their radiometric ages differed by as much as two million years. The results were not substantially changed by reducing that difference to one million radiometric years. Second, we assumed fossils were reported from the same location if they were reported in the PBDB within 2 degrees longitude or latitude. The results were not substantially changed by using 1, 3, or 4 degrees of longitude and latitude.

A visual (qualitative) inspection of Figure 1 suggests five different biostratigraphic zones, as defined by NLSSS pattern:

The Precambrian-Cambrian zone (boundaries 1-25) is characterized by very low to zero NLSSS values. This zone includes all the Archean erathem boundaries (1-5), all the Proterozoic system boundaries (5-15), and all the Cambrian stage boundaries (15-25). The only non-zero NLSSS values are boundaries 9-10, 15-16, and 21 (PBDB-reported radiometric year ages of 1800-1400, 541-529, and 500.5, respectively).

The Ordovician-Mississippian zone (boundaries 25-49) is character-

**Table 1.** The Boundary column lists the global stratigraphic boundaries utilized by the PBDB, arranged from the oldest at the top to the youngest at the bottom, identified with the names of the underlying and overlying stratigraphic units, separated by a forward slash. Note that the numbered ‘Cambrian stage’ units have not yet been given formal stage names (thus they are denoted by a lower case ‘stage’ and a number 1 through 10). Column A numbers the stratigraphic boundaries from the oldest to the youngest for easy reference in the text. Column B is the total number of different species reported in the PBDB in the global stratigraphic unit below the boundary. Column C is the Number of Local Stage-Straddling Species (NLSSS) for that boundary (the number of different species from PBDB data that are found in the global stratigraphic unit below and above the boundary at locations within 2 degrees longitude and latitude of one another). Column D is the percent change in NLSSS from the previous boundary. Column E is the total percent change in NLSSS in those cases where the NLSSS has increased or decreased over multiple successive boundaries. Column F is the %NLSSS (the percent of species below the boundary that straddle the boundary—i.e., column C divided by column B). Column G is the percentage change in %NLSSS from the previous boundary. Column H is the total percent change in %NLSSS in those cases where the %NLSSS has increased or decreased over multiple successive boundaries. Column I is the rank of a mass extinction’s intensity that occurred at or near the boundary. This rank is based on the average of several genus-level extinction studies, beginning with the most substantial extinction as a 1. Column J is North American megasequence data (B denoting the approximate beginning of the megasequence, P denoting the approximate peak, and E denoting the approximate termination of the megasequence). The last column contains the higher global stratigraphic units that bound at the same level, with the unit below the boundary mentioned first and the unit above the boundary mentioned second.

Boundary	A	B	C	D	E	F	G	H	I	J	Series	System	Erathem	Eonothem
Hadaean/Archaean	1	0	0	-		0%	-							Hadaean/Archaean
Eoarchean/Paleoarchean	2	0	0	-		0%	-							
Paleoarchean/Mesoarchean	3	8	0	-		0%	-							
Mesoarchean/Neoarchean	4	0	0	-		0%	-							
Neoarchean/Paleoproterozoic	5	2	0	-		0%	-							Archaean/Proterozoic
Siderian/Rhyacian	6	0	0	-		0%	-							
Rhyacian/Orosirian	7	0	0	-		0%	-							
Orosirian/Statherian	8	37	0	-		0%	-							
Statherian/Calymmian	9	84	7	-		8%	-						Paleo-/Mesoproterozoic	
Calymmian/Ectasian	10	82	10	43%		12%	46%							
Ectasian/Stenian	11	24	0	-100%		0%	-100%							
Stenian/Tonian	12	20	0	-		0%	-						Meso-/Neoproterozoic	
Tonian/Cryogenian	13	161	0	-		0%	-			B				
Cryogenian/Ediacaran	14	36	0	-		0%	-							
Ediacaran/Cambrian	15	203	1	-		0.5%	-					Ediacaran/Cambrian		
Fortunian/Cambrian stage 2	16	134	35	3400%		26%	5202%							
Cambrian stage 2/Cambrian stage 3	17	0	0	-100%		0%	-100%				Terreneuvian/series 2			
Cambrian stage 3/Cambrian stage 4	18	71	0	-		0%	-							
Cambrian stage 4/Cambrian stage 5	19	0	0	-		0%	-				series 2/series 3			
Cambrian state 5/Drumian	20	34	0	-		0%	-							
Drumian/Guzhangian	21	207	23	-		11%	-							
Guzhangian/Paibian	22	460	0	-100%		0%	-100%				series 3/Furongian			
Paibian/Jiangshanian	23	24	0	-		0%	-							
Jiangshanian/Cambrian stage 10	24	0	0	-		0%	-							
Cambrian stage 10/Tremadocian	25	0	0	-		0%	-					Cambrian/Ordovician		
Tremadocian/Floian	26	973	31	-		3%	-			P				
Floian/Dapingian	27	506	48	55%	235%	9%	198%	728%		E	Lo/M Ordovician			
Dapingian/Darriwilian	28	394	104	117%		26%	178%							
Darriwilian/Sandbian	29	801	50	-52%		6%	-76%			B	M/U Ordovician			
Sandbian/Katian	30	584	60	20%	114%	10%	65%							
Katian/Hirnantian	31	1962	107	78%		5%	-47%	-58%	2					
Hirnantian/Rhuddanian	32	486	21	-80%		4%	-21%		2	P		Ordovician/Silurian		
Rhuddanian/Aeronian	33	250	57	171%	352%	23%	428%							
Aeronian/Telychian	34	433	95	67%		22%	-4%	-42%						
Telychian/Sheinwoodian	35	560	74	-22%		13%	-40%				Llandovery/Wenlock			
Sheinwoodian/Homerian	36	422	88	19%		21%	58%	87%						

Table 1, continued

Boundary	A	B	C	D	E	F	G	H	I	J	Series	System	Erathem	Eonothem
Homeric/Gorstian	37	291	70	-20%		24%	15%				Wenlock/Ludlow			
Gorstian/Ludfordian	38	511	126	<u>80%</u>		25%	3%							
Ludfordian/Pridoli	39	362	65	-48%	-67%	18%	-27%	-68%	9		Ludlow/Pridoli			
Pridoli/Lochkovian	40	365	50	-23%		14%	-24%					Silurian/Devonian		
Lochkovian/Pragian	41	411	41	-18%		10%	-27%							
Pragian/Emsian	42	597	47	15%	115%	8%	-21%							
Emsian/Eifelian	43	588	49	4%		8%	6%	61%		E	Lo/M Devonian			
Eifelian/Givetian	44	694	88	<u>80%</u>		13%	<u>52%</u>		8	B				
Givetian/Frasnian	45	1277	73	-17%	-90%	6%	-55%		7		M/U Devonian			
Frasnian/Famennian	46	555	55	-25%		10%	<u>73%</u>		5					
Famennian/Tournasian	47	532	23	-58%		4%	-56%	-68%	6			Devonian/Carboniferous		
Tournasian/Visean	48	519	22	-4%		4%	-2%			P				
Visean/Serpukhovian	49	219	9	-59%		4%	-3%		6	E				
Serpukhovian/Bashkirian	50	317	10	11%	5333%	3%	-23%			B	Mississippian/Pennsylvanian			
Bashkirian/Moscovian	51	947	47	<u>370%</u>		5%	<u>57%</u>	649%						
Moscovian/Kasimovian	52	1503	127	<u>170%</u>		8%	<u>70%</u>							
Kasimovian/Gzhelian	53	707	167	31%		24%	<u>180%</u>			P				
Gzhelian/Asselian	54	1377	226	35%		16%	-31%	-40%				Carboniferous/Permian		
Asselian/Sakmarian	55	1807	257	14%		14%	-13%							
Sakmarian/Artinskian	56	1970	333	30%		17%	19%	33%						
Artinskian/Kungurian	57	2533	478	44%		19%	12%				Cisuralian/Guadalupian			
Kungurian/Roadian	58	3520	489	2%		14%	-26%							
Roadian/Wordian	59	3056	479	-2%		16%	13%	19%						
Wordian/Capitanian	60	2979	493	3%		17%	6%							
Capitanian/Wuchiapingian	61	2276	278	-44%		12%	-26%		4		Guadalupian/Lopingian			
Wuchiapingian/Changhsingian	62	2989	515	<u>85%</u>		17%	41%							
Changhsingian/Induan	63	2556	4	-99%		0.2%	-99%		1			Permian/Triassic		
Induan/Olenekian	64	787	28	<u>600%</u>	4625%	4%	2173%	5743%						
Olenekian/Anisian	65	1714	87	<u>211%</u>		5%	43%				Lo/M Triassic			
Anisian/Ladinian	66	2533	143	<u>64%</u>		6%	11%							
Ladinian/Carnian	67	2067	189	32%		9%	<u>62%</u>				M/U Triassic			
Carnian/Norian	68	1812	106	-44%		6%	-36%							
Norian/Rhaetian	69	1510	115	8%		8%	30%							
Rhaetian/Hettangian	70	1286	74	-36%		6%	-24%		3			Triassic/Jurassic		
Hettangian/Sinemurian	71	406	81	9%	164%	20%	<u>247%</u>							
Sinemurian/Pliensbachian	72	1143	195	<u>141%</u>		17%	-14%	-61%						
Pliensbachian/Toarcian	73	1646	128	-34%	-85%	8%	-54%		12					
Toarcian/Aalenian	74	1179	115	-10%		10%	25%	98%			Lo/M Jurassic			
Aalenian/Bajocian	75	246	30	-74%		12%	25%			E				
Bajocian/Bathonian	76	600	86	<u>187%</u>	963%	14%	18%							
Bathonian/Callovian	77	735	113	31%		15%	7%							
Callovian/Oxfordian	78	1592	239	<u>112%</u>		15%	-2%	-10%			M/U Jurassic			
Oxfordian/Kimmeridgian	79	1711	238	0%		14%	-7%							
Kimmeridgian/Tithonian	80	1437	319	34%		22%	<u>60%</u>			B				
Tithonian/Berriasian	81	2293	171	-46%	-87%	7%	-66%		11			Jurassic/Cretaceous		
Berriasian/Valanginian	82	1034	133	-22%		13%	<u>72%</u>							



Table 1, continued

Boundary	A	B	C	D	E	F	G	H	I	J	Series	System	Erathem	Eonothem
Valanginian/Hauterivian	83	523	48	-64%		9%	-29%							
Hauterivian/Barremian	84	417	40	-17%		10%	5%							
Barremian/Aptian	85	2137	116	190%	588%	5%	-43%	-56%						
Aptian/Albian	86	3289	140	21%		4%	-22%							
Albian/Cenomanian	87	2063	255	82%		12%	190%				Lo/U Cretaceous			
Cenomanian/Turonian	88	4475	275	8%		6%	-50%		10					
Turonian/Coniacian	89	815	53	-81%		7%	6%	211%						
Coniacian/Santonian	90	795	152	187%		19%	194%			P				
Santonian/Campanian	91	1314	101	-34%		8%	-60%							
Campanian/Maastrichtian	92	1048	139	38%	105%	13%	73%							
Maastrichtian/Danian	93	3247	207	49%		6%	-52%	-58%	3			Cretaceous/Paleogene		
Danian/Selandian	94	1372	76	-63%		6%	-13%			E				
Selandian/Thanetian	95	554	76	0%		14%	148%	176%						
Thanetian/Ypresian	96	1476	226	197%	746%	15%	12%					Paleocene/Eocene		
Ypresian/Lutetian	97	5107	577	155%		11%	-26%							
Lutetian/Bartonian	98	3594	643	11%		18%	58%	59%						
Bartonian/Priabonian	99	2693	485	-25%	-60%	18%	1%							
Priabonian/Rupelian	100	10267	257	-47%		3%	-86%					Eocene/Oligocene		
Rupelian/Chatian	101	3092	441	72%		14%	470%							
Chatian/Aquitanian	102	2359	179	-59%		8%	-47%					Oligocene/Miocene	Paleogene/Neogene	
Aquitanian/Burdigalian	103	1249	305	70%	204%	24%	222%							
Burdigalian/Langhian	104	3911	545	79%		14%	-43%	-68%						
Langhian/Serravallian	105	1395	173	-68%		12%	-11%							
Serravallian/Tortonian	106	4258	328	90%		8%	-38%							
Tortonian/Messinian	107	2319	297	-9%	-20%	13%	66%	160%						
Messinian/Zanclean	108	1382	264	-11%		19%	49%					Miocene/Pliocene		
Zanclean/Piacenzian	109	2927	586	122%		20%	5%							
Piacenzian/Gelasian	110	3477	264	-55%	-82%	8%	-62%						Neogene/Quaternary	
Gelasian/Calabrian	111	1066	107	-59%		10%	32%	429%						
Calabrian/Middle Pleistocene	112	650	131	22%	845%	20%	101%							
Middle Pleistocene/Late Pleistocene	113	2517	1011	672%		40%	99%							
Late Pleistocene/Holocene	114	5412	479	-53%		9%	-78%					Pleistocene/Holocene		

ized by low to moderate NLSSS values. This zone includes all stage boundaries of the Ordovician (25-32), Silurian (32-40), and Devonian (40-47) systems and the stage boundaries of the Pennsylvanian subsystem (47-49).

The Pennsylvanian-Permian zone (boundaries 49-63) is characterized by very high NLSSS values. This zone includes the two uppermost Mississippian subsystem stage boundaries (49-50), and all the stage boundaries of the Pennsylvanian subsystem (50-54) and the Permian system (54-63).

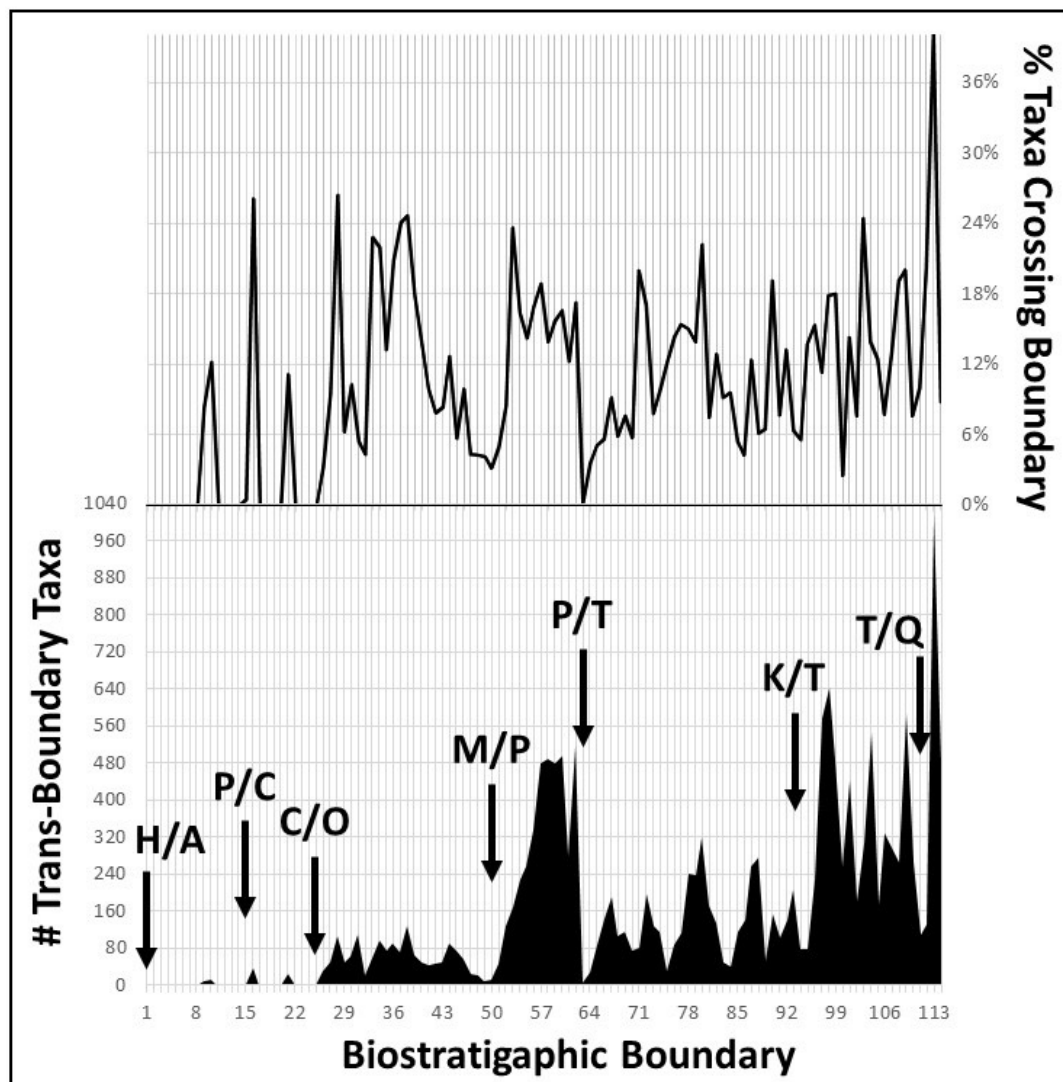
The Mesozoic zone (boundaries 63-94) is characterized by low to high NLSSS values. This zone includes the two lowest boundaries (93-94) of the Cenozoic erathem (and Tertiary sub-erathem, and Paleogene system), as well as all the boundaries of the Mesozoic erathem (63-93) and the Triassic (63-70), Jurassic (70-81), and Cre-

taceous (81-93) systems.

The Cenozoic zone (boundaries 94-114) is characterized by moderate to very high NLSSS values. This zone includes all but the lowest stage boundary of the Cenozoic erathem (93-114), the Tertiary sub-erathem (93-111), and the Paleogene system (93-102), as well as all the stage boundaries of the Quaternary sub-erathem (111-114) and the Neogene system (102-114). NLSSS values vary from 76 (boundaries 94-95) to 1011 (boundary 113). %NLSSS values vary from 6% (boundaries 94-95) to 40% (boundary 113).

Overall, the two most similar patterns seem to be the Ordovician-Mississippian and Mesozoic zones, with the latter showing a higher amplitude. In our visual inspection, we also see a potential episodic pattern in the Cenozoic zone (and even more so in the Mesozoic zone). So, we will be testing the NLSSS pattern for period-

**Figure 1.** The lower diagram is the raw number (column C, Table 1) of species on both sides of the boundary within 2 degrees longitude and latitude. The upper diagram is the percentage (column E, Table 1) of species below the boundary that straddle the boundary. **Key:** On the x-axis, 1 through 5 are the lithostratigraphic erathem boundaries of the Archean, 5 through 14 are the lithostratigraphic system boundaries of the Proterozoic, and 15 through 114 are the biostratigraphic stage boundaries of the Phanerozoic—all numbered as per column A of Table 1; C/O is the Cambrian/Ordovician boundary; H/A is the Hadean/Archean boundary; K/T is the Cretaceous/Tertiary (and Mesozoic/Cenozoic) boundary; M/P is the mid-Carboniferous Mississippian/Pennsylvanian boundary; P/C is the Precambrian/Cambrian boundary; P/T is the Permian/Triassic (and Paleozoic/Mesozoic) boundary; and T/Q is the Tertiary/Quaternary boundary.



icity.

**DISCUSSION**

**A. The Precambrian-Cambrian zone (boundaries 1-25)**

**1. Precambrian fossilization potential**

Two observations in the Precambrian data might lead to the impression that fossils are absent from Precambrian sediments. First, although the global stratigraphic units utilized by the PBDB are *bio*-stratigraphic units from the Ediacaran up, the sub-Ediacaran units are not. This might suggest that fossils are unavailable to define Precambrian stratigraphic units. Second, the zeros in column B of Table 1 might suggest that no fossils at all are found in five of the 14 globally defined stratigraphic units of the Precambrian. Concerning non-fossil definitions of Precambrian stratigraphic units, few sub-Ediacaran fossils show specificity to particular stratigraphic levels. In fact, the PBDB reports fossils in every globally-defined stratigraphic unit of the Precambrian-Cambrian zone. It is just that few of them have a narrow enough stratigraphic range to be useful for biostratigraphy. Concerning the zeros in column B of Table 1, many of the fossil taxa in the Precambrian-Cambrian zone are simply not reported at the species level. So again, all the globally

defined Precambrian stratigraphic units contain fossils. It is just that few of those fossils are identified at the species level. So, unlike Hunter (2000a, 2000b) claims, not only are Precambrian sediments quite capable of preserving fossils, they, in fact, do contain fossils.

**2. Biostratigraphic pulses in the Precambrian-Cambrian zone**

There is too little data in the Precambrian-Cambrian zone to place statistical confidence on quantitative tests of periodicity. Qualitatively, however, there seems to be no evidence of periodicity in the radiometric ages of stage boundaries or their logarithms (in case there is exponential change in decay rates during the deposition of these stratigraphic units). However, there may be regularity in the NLSSS zeros and highs. A rough test of periodicity for every 2<sup>nd</sup> boundary was performed by (1) summing the %NLSSS values (column F, Table 1) for every 2<sup>nd</sup> boundary starting at boundary 1 (2s<sub>1</sub>), then summing the %NLSSS values for every 2<sup>nd</sup> boundary starting at boundary 2 (2s<sub>2</sub>), (2) calculating the percentage that each of these sums are of the sum of all %NLSSS values (2p<sub>1</sub> and 2p<sub>2</sub>), and (3) comparing these percentages with what would be expected if there was no 2<sup>nd</sup> boundary periodicity (1/2 = 50%). The same test was performed for periodicity for every 3<sup>rd</sup> boundary (by summing %NLSSS values for every 3<sup>rd</sup> boundary to get 3s<sub>1</sub>, 3s<sub>2</sub>, and 3s<sub>3</sub>, then comparing calculated

$3p_1, 3p_2, 3p_3$  values with  $1/3 = 33\%$ ). Similarly periodicity was tested for every 4<sup>th</sup>, every 5<sup>th</sup>, and every 6<sup>th</sup> boundary. This test is similar to the one used by Raup and Sepkoski (1984) to identify a 28-million-radiometric-year periodicity in mass extinctions. The results of this periodicity test are found in Table 2. The largest deviations from non-periodicity for NLSSS peaks are every five boundaries starting with boundary 1 (3.8 times the value expected in non-periodic data) and every six boundaries starting with boundary 4 (3.6 times the value expected in non-periodic data). Visually, this is seen by NLSSS peaks at boundaries 10, 16, 21 (and 26) lying very close to every 5<sup>th</sup> boundary beginning with boundary 1 (1, 6, 11, 16, 21 [and 26]), as well as every 6<sup>th</sup> boundary beginning with boundary 4 (4, 10, 16, 22). A visual inspection of peaks in species diversity (column B, Table 1) below boundaries 3, 5, 9, 13, 15, 18, and 22 may also indicate species diversity peaks in every 3<sup>rd</sup> stratigraphic unit. These observations seem to offer sufficient warrant to at least further investigate periodicity in future studies. Since studies of this nature should operate on more data, we recommend using a coarser taxonomic measure (e.g., of genera and/or families). This should substantially increase the available data since many fossils in the Precambrian-Cambrian zone are identified no more precisely than the genus, or even family.

Demonstrating periodicity in the Precambrian-Cambrian NLSSS data, however, does not automatically demonstrate any sort of periodicity in time or process. With respect to time, the good news is that the International Commission on Stratigraphy is attempting to make all stratigraphic units of a given level (all stages, all series, etc) roughly the same length, albeit in radiometric years. The bad news is that the finest globally defined stratigraphic units currently defined in the Precambrian-Cambrian zone are erathems in the Archean, systems in the Proterozoic, and stages in the Cambrian. The result is that the stratigraphic units between boundaries 1-25 decrease in radiometric length by two orders of magnitude. In fact, a majority of that decrease occurs between the Precambrian and Cambrian. The four Archean (erathem) units average 375 million radiometric years in length, the ten Proterozoic (system) units average 225, and the ten Cambrian (stage) units 5.6. It is not immediately evident how radiometric time is to be converted to true time. Thus, it may be difficult demonstrating that periodicity in NLSSS data is actually periodicity in time. With respect to periodicity of process, the different stratigraphic units of the Precambrian-Cambrian zone may have resulted from very different processes operating at very different periods of earth history. If the pre-Flood/Flood boundary is at boundary 13, as suggested by Austin and Wise (1994), fossils between boundaries 13 and 25 were buried in the Flood. If the oldest Precambrian fossils were buried in the Day 3 Regression, as suggested by Wise (1992), the lower part of the Precambrian-Cambrian zone was formed in the Creation Week. It may also turn out that some of the Precambrian-Cambrian zone sediments were formed after the Creation Week and before the Flood. Thus some Precambrian-Cambrian zone fossils may have formed as part of God's creative activity in the Creation Week, some through more 'normal' processes of antediluvian times, and some as part of God's judgment during the Flood. Thus, it may be difficult demonstrating that periodicity in NLSSS data translates to periodicity of the same process or processes.

Periodicity in time or process may or may not be demonstrated in NLSSS data. However, significantly high and low NLSSS values

still suggest non-uniformity of process. It might be that they point to different processes operating at different times (e.g., Creation Week versus antediluvian versus Flood processes). Or, they may indicate similar processes operating at different rates—again, e.g., at different times of earth history. Or, if they are found to occur within a single catastrophic event—such as during the Day 3 Regression or the Flood—they may point to processes capable of separating different cohorts of organisms into different strata. Or, they may point to a combination of these possibilities (and perhaps other possibilities we have not yet considered). In any case, the variable NLSSS values of the Precambrian-Cambrian zone should be examined more carefully.

### 3. The pre-Flood/Flood boundary

In the creation model, we would expect the pre-Flood/Flood boundary to be located in the lower part of the stratigraphic column. Furthermore, in theory, either the species diversity data of column B in Table 1 or the NLSSS data of column C in Table 1 could—in principle, anyway—be used to identify the pre-Flood/Flood boundary in at least two different ways. Regarding the species diversity data, creationists have long believed that the Flood involved a marked increase in the burial rate of organisms (over whatever the burial rate of organisms was in pre-Flood times). Unless the catastrophism of the earliest Flood was so great as to destroy the organisms—and thus leave no fossils—creationists would expect a marked increase in numbers—and diversity—of fossils at the beginning of the Flood. However, the species diversity in the lowest stratigraphic units of our planet (column B in Table 1) do not show consistently low values (of the pre-Flood world) previous to a sudden increase to consistently high values (of the Flood). The diversity below boundaries 1-7 is consistently low (as might be expected of the pre-Flood world), and the diversity above boundary 26 is consistently high (as might be expected of the Flood). However, boundaries 8-25 show rises and falls in diversity unexpected in most views of the Flood and the world previous to it. *Ad hoc* explanations could be devised to explain such things in the antediluvian world (e.g., periods of pre-Flood catastrophism to explain diversity highs) or during the Flood (e.g., sections of pre-Flood ocean floor lacking organisms to explain diversity lows). But in actuality, PBDB species diversity data does not permit the pre-Flood/Flood boundary to be located any more precisely than somewhere between boundaries 8 and 25.

Regarding the use of NLSSS data to identify the pre-Flood/Flood boundary, creationists almost universally believe that the early Flood involved considerable transport. The geographic ranges of pre-Flood organisms are usually assumed to be constant or changing very slowly between the Creation and the Flood. Thus, if fossils formed in successive layers in the pre-Flood world, species found in one layer should be found in the next layer in the same geographic locality. Thus if fossilization occurred over the course of antediluvian times, NLSSS values would be high in pre-Flood sediments. On the other hand, if the early Flood was as catastrophic as creationists usually assume, species would be carried from where they lived in pre-Flood times to be buried in very different locations. Pre-Flood fossils of a species would not be expected to be in the same geographic location as the earliest Flood fossils of that same species. We would expect zero or near-zero NLSSS values for the pre-Flood/Flood boundary. However, once a species has been picked up by the Flood waters,



**Table 2.** Periodicity was tested for every 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> boundary (far right column) in each of the five NLSSS biostratigraphic zones. For each periodicity tested (i.e., each row), the percentages of summed NLSSS values (column C, Table 1) are compared with the percentage expected if there was no periodicity in the data (second column). Underlined percentages are values at least 50% greater or lesser than expected if no periodicity.

NLSS biostratigraphic zone	expectation with periodicity	% of summed NLSSS values beginning with boundary number						
		1	2	3	4	5	6	
Precambrian-Cambrian zone	50%	41%	59%					every 2 <sup>nd</sup> boundary
	33%	<u>59%</u>	<u>0%</u>	41%				every 3 <sup>rd</sup> boundary
	25%	<u>39%</u>	<u>13%</u>	<u>1%</u>	<u>46%</u>			every 4 <sup>th</sup> boundary
	20%	<u>76%</u>	<u>0%</u>	<u>0%</u>	<u>9%</u>	14%		every 5 <sup>th</sup> boundary
	17%	<u>0%</u>	<u>0%</u>	<u>41%</u>	<u>59%</u>	<u>0%</u>	<u>0%</u>	every 6 <sup>th</sup> boundary
Ordovician-Mississippian zone	50%	46%	54%					every 2 <sup>nd</sup> boundary
	33%	37%	31%	32%				every 3 <sup>rd</sup> boundary
	25%	21%	28%	25%	26%			every 4 <sup>th</sup> boundary
	20%	22%	14%	25%	21%	18%		every 5 <sup>th</sup> boundary
	17%	<u>16%</u>	<u>18%</u>	<u>17%</u>	<u>21%</u>	<u>13%</u>	<u>15%</u>	every 6 <sup>th</sup> boundary
Pennsylvanian-Permian zone	50%	44%	56%					every 2 <sup>nd</sup> boundary
	33%	30%	38%	32%				every 3 <sup>rd</sup> boundary
	25%	23%	32%	20%	25%			every 4 <sup>th</sup> boundary
	20%	17%	28%	17%	19%	19%		every 5 <sup>th</sup> boundary
	17%	<u>14%</u>	<u>22%</u>	<u>13%</u>	<u>16%</u>	<u>16%</u>	<u>18%</u>	every 6 <sup>th</sup> boundary
Mesozoic zone	50%	47%	53%					every 2 <sup>nd</sup> boundary
	33%	33%	29%	38%				every 3 <sup>rd</sup> boundary
	25%	24%	24%	23%	29%			every 4 <sup>th</sup> boundary
	20%	18%	25%	24%	14%	19%		every 5 <sup>th</sup> boundary
	17%	<u>19%</u>	<u>20%</u>	<u>19%</u>	<u>14%</u>	<u>9%</u>	<u>19%</u>	every 6 <sup>th</sup> boundary
Cenozoic zone	50%	54%	46%					every 2 <sup>nd</sup> boundary
	33%	30%	44%	26%				every 3 <sup>rd</sup> boundary
	25%	<u>37%</u>	26%	17%	19%			every 4 <sup>th</sup> boundary
	20%	15%	16%	<u>30%</u>	<u>29%</u>	<u>10%</u>		every 5 <sup>th</sup> boundary
	17%	<u>20%</u>	<u>19%</u>	<u>10%</u>	<u>11%</u>	<u>24%</u>	<u>15%</u>	every 6 <sup>th</sup> boundary

that same species will continue to be deposited in successive Flood sediments until all members of that species have been buried. Thus, NLSSS values should be zero or near-zero for the pre-Flood/Flood boundary and non-zero at boundaries above and below the pre-Flood/Flood boundary. Considering the NLSSS values in the earth's oldest stratigraphic units (column C in Table 1), possible pre-Flood/Flood boundaries are 8, 11-14, 17-20, and 22-25. This involves the same range of possibilities suggested by species diversity data. More data is necessary to use NLSSS data as a criterion for the pre-Flood/Flood boundary. In particular, since there are fossils in each one of these stratigraphic units, the zeros in column B of Table 1 suggest that many of those fossils are not identified at a species level. Thus,

as in the case of the possible periodicity in the Precambrian-Cambrian zone, we suggest a reanalysis using genera and/or families.

#### 4. Pre-Flood catastrophism

Somewhere between 6 and 24 globally defined stratigraphic units are below the pre-Flood/Flood boundary. Typically each of these units includes hundreds to thousands of feet of sediment. Under non-catastrophic conditions, taxa should remain in the same geographic area from the deposition of one stratigraphic unit to the next. The absolute probability of preservation should be lower under non-catastrophic conditions, leading to lower fossil diversity. However, the %NLSSS values should be high during non-catastrophic periods of earth his-

tory. The low %NLSSS values (column F, Table 1) suggest most of the Precambrian-Cambrian zone sediments were not deposited over a long period of time. And, if the pre-Flood/Flood boundary is at boundary 13 as Austin and Wise (1994) argue, low %NLSSS values in boundaries 8-12 suggest most of the pre-Flood sediments were not deposited over a long period of time. Thus, pre-Flood sediments were most probably deposited under catastrophic conditions, at rates well above those hypothesized by non-creationist geologists. This hypothesis can be tested by re-examining this zone with a NLSSG (genus-level) and/or NLSSF (family-level) paleontological continuity criterion.

## 6. Early Flood biozonation

Creationists almost universally assign Cambrian sediments to the Flood. Yet, only 59 (5.2%) of 1133 species reported from a Cambrian stage are reported also in the following stage. None of the 71 species below boundary 18 are reported from the following stage, and none of the 34 below boundary 20, and none of 460 species below boundary 22. This suggests strong species-level biozonation at the stage level in the Cambrian. Wise (2003a) argued that the biostratigraphic zones of the Ediacaran and lowest Cambrian might be explained by fining upward deposition at the initiation of the Flood. The entire Cambrian is within the Sauk megasequence, and the Sauk is characterized by fining upward sedimentation. In future research we will be pursuing the possibility that the decreasing depositional energy of the Sauk megasequence may be responsible for the strong biozonation in Cambrian sediments.

### B. The Cenozoic zone (boundaries 94-114)

#### 1. The Flood/post-Flood boundary

In the creation model, we would expect the Flood/post-Flood boundary to be located in the upper part of the stratigraphic column. Thus, we might expect the Flood/post-Flood boundary to be located somewhere in the uppermost NLSSS biostratigraphic zone—i.e., the Cenozoic zone. And, just as NLSSS data could, in principle, be used to define the pre-Flood/Flood boundary, so also NLSSS data can be used to define the Flood/post-Flood boundary. As claimed above, once a species was picked up (and killed) by the Flood waters, that same species will continue to be deposited in successive Flood sediments until all members of that species have been buried or destroyed. Thus, a fossil species found in a particular Flood sediment at some geographic location might well be found also in the next Flood sediment at that same location. Thus, successive Flood layers should show high NLSSS values for species killed in the Flood. Although the Flood was designed to kill all terrestrial animals, some marine species may not have been killed by Flood waters. In fact the nutrient-rich waters of the Flood may have allowed some marine species to flourish, reproduce and multiply. Such Flood-compatible organisms with short enough generation times—especially bacteria, protists, and algae—may have even been able to adapt to local conditions in the course of the Flood. Given that these organisms might live at the same locality through the deposition of multiple sedimentary units of the Flood, they should also show high NLSSS values. Thus, we would expect high NLSSS values for organisms of all types throughout Flood sediments. We would also expect high NLSSS values for organisms of all types in post-Flood sediments. This is be-

cause organisms that lived in a particular area while one stratigraphic unit was being deposited are very likely to live in the same area while the next stratigraphic unit was being deposited in that same area. In contrast, we would *not* expect high NLSSS values across the Flood/post-Flood boundary. If any marine species killed off by the Flood was buried in a particular location by Flood sediments, the Flood's wholesale rearrangement of the marine realm would make it very unlikely that that species' Flood survivors would come to inhabit the same geographic location. The only exceptions might be some of the species that actually thrived in Flood waters. Such species could potentially find an acceptable marine habitat before the end of the Flood and persist in that habitat following the Flood. For terrestrial organisms this is not possible, for the only terrestrial animals that survived the Flood did so on the ark. If all the Flood fossils for a particular terrestrial species were restricted to a small geographical area, it would be extremely unlikely that the members of the species coming out of the ark would establish their post-Flood habitation at that same spot. NLSSS values for terrestrial organisms might be high in Flood and post-Flood sediments, but should be zero across the Flood/post-Flood boundary. Consequently, we would expect high NLSSS values below and above the Flood/post-Flood boundary, but zero NLSSS values at the boundary (except for marine species that established themselves before the end of the Flood).

The very high NLSSS values in the Cenozoic zone seem incompatible with a Flood/post-Flood boundary anywhere after boundary 95 (low in the Cenozoic). If the Flood/post-Flood boundary was located at any of these stage-stage boundaries, hundreds of species would be buried in the same geographic area on each side of that boundary. In a similar manner, Ross (2012) claimed that scores of terrestrial mammal genera (and families) on both sides of the Tertiary/Quaternary (T/Q) boundary in North America argue very persuasively against the Flood/post-Flood boundary at the T/Q boundary in North America. It seems too improbable for even one terrestrial mammal to leave the ark after the Flood, travel to a location half-way around the world, and settle in the very same area where members of its genus were buried in the Flood. For this to happen for scores of different mammal genera (and families) makes it impossible for the Flood/post-Flood boundary in North America to be located at the Tertiary/Quaternary boundary. There are two ways in which our analysis is even more definitive than Ross'. First, it is much less probable that a particular species will reinhabit the same geographic location than it is for any species of a given genus (or family) to reinhabit the same geographic location. Second, it is far less probable to relocate within 2 degrees longitude and latitude than it is to relocate somewhere on the same continent. Furthermore, our analysis broadens Ross's conclusions from just the T/Q boundary (our boundary 111) to all biostratigraphic boundaries, and from just North America to the entire globe. Ross concluded that the Flood/post-Flood boundary cannot be at the T/Q boundary in North America. Our analysis concludes that the Flood/post-Flood boundary cannot be anywhere in the Neogene or upper Paleogene anywhere in the world. All this having been said, however, there is one sense in which Ross's (2012) analysis was more effective than ours in identifying the Flood/post-Flood boundary. Ross only utilized terrestrial mammals, and for such organisms we would expect an unambiguous NLSSS value of zero at the Flood/

post-Flood boundary. However, non-zero NLSSS values are possible for marine organisms that established themselves before the end of the Flood. For our analysis to be a definitive argument against a middle or upper Cenozoic Flood/post-Flood boundary, it should be repeated on entirely terrestrial organisms.

An interesting peculiarity of earth history suggests yet another criterion for identifying the Flood/post-Flood boundary. As is almost universally accepted by creationists, continental glaciation occurred entirely after the Flood. When continental glaciation was at its maximum, enough water was trapped in continental glaciers to drop global sea level about 130 meters from post-Flood, pre-glacial times. Although subsequent melting of these glaciers has raised sea level substantially, sea level is still about 80 meters below pre-glacial levels. As a result of this, the lowest 80 meters of super-tidal sediments on continental margins (and higher sediments that have been tectonically raised since deposition) are marine shelf sediments from post-Flood, pre-glacial times. Being above sea level as they are, these coastal plain sediments are easily scoured for fossils, so the PBDB has thousands of records of fossils from post-Flood marine sediments that would otherwise be largely unknown to us if they were still below sea level. Because these are places where marine taxa could have established themselves before the end of the Flood, NLSSS values could be high in coastal plain sediments around the world. Thus, the NLSSS values for terrestrial taxa should be high everywhere below the Flood/post-Flood boundary, zero at the boundary, and high on the continents interior to their coastal plain sediments and zero elsewhere. At the same time, NLSSS values for marine taxa below the Flood/post-Flood boundary will be high everywhere, and above the Flood/post-Flood boundary should be high in coastal plain sediments and zero on the continents interior to their coastal plain sediments. When we examined the boundary-straddling species of the Cenozoic zone, terrestrial taxa were almost exclusively restricted to continental localities interior to coastal plain locations. The few exceptions could be explained by terrestrial organisms washed out to sea. For the same boundaries, marine taxa are restricted to coastal plain localities in all areas of the world except one large region—the mountain chain stretching from central Europe through the Middle East and across the top of India. Woodmorappe (1983: map 34) mapped the very same distribution of Cenozoic index fossils. Clarey (2017, 2020; Clarey and Werner 2019) noted marine sediments in the Cenozoic of central Europe, Turkey, and the Middle East—i.e., along the same chain of Eurasian mountains. We suspect that a close examination of the mountain fold-belt stretching from Europe through China will reveal that the Cenozoic marine sediments were all deposited along continental margins just above current sea level, and were subsequently uplifted to modern elevations by late Cenozoic plate collisions. If this hypothesis proves true, all marine boundary-straddling species worldwide are restricted to coastal plain sediments throughout the Cenozoic and all terrestrial boundary-straddling taxa are restricted to the continents interior to the coastal plain sediments (except those washed out to sea). We would consider this extremely strong evidence that all or nearly all the Cenozoic is post-Flood.

Definitive arguments for the location of the world's Flood/post-Flood boundary must await NLSSS reanalysis of terrestrial vs. marine organisms and a geologic study of the Eurasian mountains. However, we did examine the terrestrial vs. marine boundary-straddling

species of North America for the location of the Flood/post-Flood boundary in North America. Starting with the uppermost stage-stage boundary (boundary 114), marine boundary-straddling species are restricted to coastal plain sediments in boundaries 114 through 112, absent altogether in boundary 111, and restricted to coastal plain sediments, again, in boundaries 110 through 94. In contrast, terrestrial boundary-straddling taxa are found at continental locations interior to coastal plain sediments at boundary 93 down (e.g., at 56 of the 57 continental interior locations at boundary 93, 5 of the 12 at boundary 92, 2 of the 3 at boundary 91, and 22 of the 23 at boundary 90). This strongly argues that the Flood/post-Flood boundary is located just below boundary 94—i.e., just below the Danian/Selandian boundary (the first biostratigraphic boundary above the Cretaceous/Paleogene boundary). The fact that this boundary (and the one following it) represent a substantial worldwide dip in boundary-straddling species provides further justification for this being the Flood/post-Flood boundary in North America.

## 2. Biostratigraphic pulses in the Cenozoic zone

In the Cenozoic zone there are 6 NLSSS peaks (boundaries 98, 101, 104, 106, 109, 113) and 5 NLSSS valleys between (boundaries 100, 102, 105, 108, 111). This alone suggests a periodicity of peaks every 3-4 boundaries or so. Our periodicity test did offer mild support to NLSSS periodicity (see Table 2). Every 4<sup>th</sup> boundary starting with the first boundary, every 5<sup>th</sup> boundary starting with the third and fourth boundaries, and every 6<sup>th</sup> boundary starting with the fifth boundary, all sum to values 1½ times the expected value if there was no periodicity. Thus the peaks at boundaries 98, 101, 104, 106, 109, 113, closely correspond to every 4<sup>th</sup> beginning with the 1<sup>st</sup> (94, 98, 102, 106, 110, 114), every 5<sup>th</sup> beginning with the 3<sup>rd</sup> (96, 101, 106, 111) or 4<sup>th</sup> (97, 102, 107, 112), and every 6<sup>th</sup> starting with the 5<sup>th</sup> (98, 104, 110).

As in the case of the Precambrian-Cambrian zone, however, demonstration of periodicity in Cenozoic NLSSS is not automatically a demonstration of periodicity in time. If the Flood runs from somewhere between boundaries 8 and 25 to about boundary 94, then somewhere between 479 and 1738 million radiometric years elapsed during the year-long Flood, and only 61.6 million radiometric years elapsed in the last four and a half thousand years or so. And, if Lubenow (1992) is correct about *Homo erectus* being human, then the Old-World-wide distribution of the oldest *H. erectus* suggests that all of both the Pleistocene and Holocene are post-Babel. That would suggest that 479-1738 million radiometric years elapsed in 1 Flood year, then about 52.8 million radiometric years elapsed in a few centuries between the Flood and the Babel dispersion, and 1.8 million radiometric years elapsed in the four and half or so thousand years since Babel. As in the case of the Precambrian-Cambrian zone, then, it is not yet clear what the relationship is between radiometric and chronological time. Thus, it may be difficult demonstrating that periodicity in NLSSS data is actually periodicity in time.

Even if the NLSSS peaks in the Cenozoic zone cannot be demonstrated to be periodic, they do seem rather dramatic. Eight boundaries show NLSSS increases of 50% or more over the previous boundary, and half of those more than doubled (column D, Table 1). Seven boundaries show %NLSSS increases of 50% or more over the previous boundary, and four of those more than doubled (column



G, Table 1). Considering total NLSSS increases, even over multiple boundaries, there were 6, with total increases of 746%, 72%, 204%, 90%, 122%, and 845% (columns D and E, Table 1). There were also 6 such %NLSSS increases (176%, 59%, 470%, 222%, 160%, 429%: columns G and H, Table 1). Five boundaries show NLSSS decreases of 50% or more over the previous boundary (column D, Table 1), and three show %NLSSS decreases of 50% or more (column G, Table 1). Considering total NLSSS decreases, even over multiple boundaries, there were 5 (60%, 58%, 68%, 82%, and 53% (columns D and E, Table 1). There were also 4 such %NLSSS decreases (86%, 68%, 62%, and 78%: columns G and H, Table 1). Thus, even when NLSSS data is normalized to the number of species in the preceding stage—i.e., as %NLSSS data—the rises and drops in NLSSS data are substantial. As indicated above, substantial changes in NLSSS and %NLSSS values suggest non-uniformity of process. Investigation of these data in the Cenozoic zone may provide insight into surges in post-Flood catastrophism and/or surges in post-Flood diversification.

## B. The Ordovician through Mesozoic zones (boundaries 25-94)

With the pre-Flood/Flood boundary in the first NLSSS biostratigraphic zone, and the Flood/post-Flood boundary in the fifth, the second through fourth NLSSS biostratigraphic zones (boundaries 25-94) were deposited in the Flood.

### 1. Possible sea-to-land pattern

From at least the time of Clark (1946), creationists have suggested that the oldest animal fossils were marine because the Flood began its burial of organisms in the earth's oceans. This suggests that the first-order biostratigraphic zonation of Flood sediments might separate a lower marine zone from an upper terrestrial zone. At the same time, since the ark was not designed to carry marine organisms, and marine fossils are found at every stage of the Flood, marine organisms must have been buried throughout the entire Flood year. Thus, the upper terrestrial zone must contain marine fossils as well as terrestrial fossils. If we assume that burial processes of the Flood were similar between the upper and lower zones, the upper zone might differ from the lower zone only in the addition of terrestrial organisms. When terrestrial and marine organisms are not distinguished, the second zone may only differ in total species diversity. It strikes us that in Figure 1 the 2<sup>nd</sup> and 4<sup>th</sup> NLSSS biostratigraphic zones look similar, except that the 4<sup>th</sup> has higher amplitude peaks. In fact, the sums of the stage-level species diversity (column B, Table 1) in the 4<sup>th</sup> zone is 3.4 times that of the 2<sup>nd</sup> zone, and the sums of the NLSSS values (column C, Table 1) in the 4<sup>th</sup> zone is 2.9 times that of the 2<sup>nd</sup> zone. We would like to suggest that the 4<sup>th</sup> (Mesozoic) zone is the above-mentioned 'terrestrial' zone (containing both terrestrial and marine organisms), and the 2<sup>nd</sup> (Ordovician-Mississippian) zone is the above-mentioned 'marine' zone (containing only marine organisms). We would expect that if terrestrial and marine taxa were evaluated separately, the marine taxa will be similar in both pattern and diversity between the 2<sup>nd</sup> and 4<sup>th</sup> zones, and the terrestrial taxa will be restricted to the 4<sup>th</sup> zone, but show a similar NLSSS pattern as the marine taxa in both the 2<sup>nd</sup> and 4<sup>th</sup> zones.

If the 2<sup>nd</sup> and 4<sup>th</sup> zones are the 'marine' and 'terrestrial' zones of the Flood, the 3<sup>rd</sup> zone would logically represent Flood sedimentation as the ocean began inundating the land. Three other considerations

suggest that might be true. First, considerable sand might have been located at or near pre-Flood shorelines—such as in the form of beach sand and/or sand dunes. If so, then considerable sand deposits would have been swept away and deposited by Flood waters as the Flood first moved onto the land. The extensive sand deposits of the Permian-Triassic around the world are not only of the right nature for these deposits, but they date from the 3<sup>rd</sup> NLSSS biostratigraphic zone. Second, Wise (2003b) hypothesized that the pre-Flood ocean was home to a continent-sized floating forest biome. Early Flood turmoil might have ripped off and buried the most fragile components of the outermost perimeter of the floating forest (beginning with the fragile plants of the Silurian). However, as long as the floating forest biome was located in deep water, it would probably have remained largely intact. No matter how large the waveform, as long as the wave did not crest, the floating forest could probably deform to, and ride out the waves. It was likely to have been when the floating forest was brought into contact with the edge of the continent that it was systematically torn apart and its components buried. This would likely have been as the Flood began transgressing the land. Floating forest organisms are deposited from the upper Silurian into the lower Triassic, with the greatest bulk of them in the Carboniferous. This suggests that the Flood began transgressing the land somewhere between the upper Silurian and lower Triassic, and most likely somewhere in the Carboniferous. This measure of the transgression of the land occurs within or just before the 3<sup>rd</sup> NLSSS biostratigraphic zone. Third, the greatest *diversity* of floating forest organisms is in the Pennsylvanian through Permian. Such a large diversity from a single ecosystem might explain the consistently large NLSSS values in the 3<sup>rd</sup> NLSSS biostratigraphic zone. Thus, we suggest that the Pennsylvanian-Permian NLSSS zone represents the Flood's initial inundation of the land. We predict that when the organisms of Flood rocks are separated into floating forest organisms versus 'true' marine organisms versus 'true' land organisms, the true marine signature will remain unchanged through all Flood sediments. We also predict that the true land signature will be absent up until somewhere in the Pennsylvanian-Permian zone, and remain unchanged thereafter.

### 2. Biostratigraphic pulses in Flood sediments

NLSSS peaks are located at boundaries 28, 31, 34, 36, 38, and 44 in the Ordovician-Mississippian zone, boundaries 58, 60, and 62 in the Pennsylvanian-Permian zone, and boundaries 67, 72, 80, 88, 90, and 93 in the Cenozoic zone (column C, Table 1). %NLSSS peaks are located at boundaries 28, 30, 33, 38, 44, 46 in the Ordovician-Mississippian zone, boundaries 53, 57, 60, 62 in the Pennsylvanian-Permian zone, and boundaries 67, 69, 71, 77-78, 80, 82, 84, 87, 90 in the Cenozoic zone (column F, Table 1).

In spite of what might appear to be regularity in the data, our periodicity test (see above) does not suggest periodicity in Flood sediments (see Table 2). Even if the peaks and valleys do not show periodicity, though, like the sediments of the Cenozoic, the peaks and valleys do seem to be substantial. Nineteen boundaries show NLSSS increases of 50% or more over the previous boundary, and eleven of those more than doubled (column D, Table 1). Eighteen boundaries show %NLSSS increases of 50% or more over the previous boundary, and twelve of those more than doubled (column G, Table 1). Considering total NLSSS increases, even over multiple bound-



aries, there were 13 with increases exceeding 50%, and 11 of those more than doubled (columns D and E, Table 1). There were also 15 such %NLSSS increases, and 7 of those more than doubled (columns G and H, Table 1). Seven boundaries show NLSSS decreases of 50% or more over the previous boundary (column D, Table 1), and eleven show %NLSSS decreases of 50% or more (column G, Table 1). Considering total decreases, even over multiple boundaries, 8 NLSSS decreases exceeded 50% (columns D and E, Table 1) and 12 %NLSSS decreases exceeded 50%. Thus, even when NLSSS data is normalized to the number of species in the preceding stage—e.g., as %NLSSS data—the rises and drops in NLSSS data are substantial. As indicated above, substantial changes in NLSSS and %NLSSS values suggest non-uniformity of process. Investigation of these data in the Flood sediments may provide insight into pre-Flood biozonation and/or Flood processes that can separate organisms and/or preserve pre-Flood organismal associations.

### 3. NLSSS data and biostratigraphic units and events

We have argued that NLSSS data divides the earth's stratigraphic column into five global, biostratigraphic units. The earth's stratigraphic column has been divided into other global biostratigraphic units for a very long time—many of them for more than a century. How do these biostratigraphic units compare to the NLSSS biostratigraphic units? At the coarsest scale, the Phanerozoic is divided into the Paleozoic, Mesozoic, and Cenozoic erathems. The last two correspond rather closely with the Mesozoic and Cenozoic NLSSS zones. The Paleozoic erathem might correspond to the 'marine' biozone of the Flood if (1) further study of the Paleozoic-Cambrian zone reassigns the Cambrian as part of the 'marine' biozone of the Flood and (2) taking out the floating forest organisms also unites the Pennsylvanian-Permian NLSSS zone to the 'marine' biozone of the Flood. If so, then (roughly speaking) the Cenozoic erathem and NLSSS zone are both post-Flood, the Mesozoic erathem and NLSSS zone are the 'terrestrial' biozone of the Flood, the Paleozoic erathem and NLSSS zone are the 'marine' biozone of the Flood, and the Precambrian would be pre-Flood. Erathems, then, may well be evidenced in NLSSS data.

However, none of the biostratigraphic divisions of the erathems down to the level of stages (e.g., series and/or systems) are evidenced in NLSSS data. We see nothing in the NLSSS or %NLSSS data (columns C or F, Table 1) that seems to consistently match any of the system or series boundaries (far right column, Table 1). Lyell created the first divisions of the Cenozoic based on the percent living mollusk species, but almost all biostratigraphic divisions of the erathems have, since then, been defined with respect to 'index fossils'. Index fossils are geographically widespread taxa (optimally global) that are restricted to one narrow zone of the stratigraphic column. The lack of correlation between NLSSS data and any biostratigraphic zones between the stage and the erathem, suggests 'index fossils' might carry no special signature other than their very particular biostratigraphic position.

'Mass extinctions' are not biostratigraphic units. But, 'mass extinctions' are positions in the global biostratigraphic column where a large percentage of taxa below that position are never seen above that position. In principle, the disappearance of many taxa across a boundary would imply a change in organismal composition from one

stratigraphic unit to the next. If enough taxa disappeared, this would result in a biostratigraphic boundary. The more global the disappearance, the more global will be the biostratigraphic boundary. One would then expect 'mass extinctions' to be found at biostratigraphic boundaries, and the largest 'mass extinctions' at the coarsest biostratigraphic boundaries. One would also expect sudden drops in number of taxa to correspond to very low NLSSS values. Since 'mass extinctions' are nothing more than higher than 'normal' 'extinction rate,' they are arbitrarily defined. There is no consensus on what is a 'higher than normal' extinction rate. There is also no consensus on how to measure the relative size of different 'mass extinction' events. However, column I in Table 1 lists the twelve most substantial 'mass extinctions' according to a roughly estimated rank (with '1' exhibiting the highest 'extinction rate'). As we might expect, the 1<sup>st</sup>- and 3<sup>rd</sup>-ranked 'mass extinctions' do correspond to the boundaries between the three erathems and the upper three NLSSS biostratigraphic zones (comparing C, I, and far right columns, Table 1). The 1<sup>st</sup>-ranked 'mass extinction' also corresponds to the largest percentage drop in %NLSSS values (column G, Table 1). The 2<sup>nd</sup>-, 4<sup>th</sup>-, and 5<sup>th</sup>-ranked 'mass extinctions' do correspond to system boundaries, but the relationship between 'mass extinctions' and biostratigraphic boundaries blurs after that. Most of the 'mass extinctions' are at or near drops in NLSSS values, but there does not seem to be a relationship between the ranking of 'mass extinctions' and the percentage drop in %NLSSS values (columns F versus I, Table 1). 'Mass extinctions,' then, like NLSSS values, do not seem to strongly support the system and series divisions of the erathems.

### 4. Megasequences and biostratigraphic data

Sloss's (1964) North American megasequences can be documented globally (e.g., Clarey and Werner 2018). The last of Sloss's 'megasequences'—the Tejas—is not bound above by an unconformity, nor is it characterized by fining upward clastics topped by a carbonate, nor are its distinct lithologies typically traceable across continents. The other five (the Sauk, the Tippecanoe, the Kaskaskia, the Absaroka, and the Zuni) are megasequences *sensu stricto* (unconformity-bound sequences of continent-wide, fining upward clastics, topped with continent-wide carbonate). Each megasequence *sensu stricto* suggests an enormous global surge in water energy followed by diminution of energy. And, since each one of them left sediments in the interior of continents, they each appear to be global inundations indicative of the Flood. Alone, these five megasequences suggest the Flood ran from the Tonian/Cryogenian boundary (boundary 13) to the Danian/Selandian boundary (boundary 94). This is consistent with the Flood boundaries derived from NLSSS data (somewhere between boundary 8 and 25 to boundary 94).

Beyond the overall beginning and ending of the Flood, however, there does not seem to be any correlation between megasequences *sensu stricto* and either the NLSSS data or the biostratigraphic divisions of the stratigraphic column. We see no connection between the beginnings, the peaks, or the terminations of the five megasequences *sensu stricto* (column J, Table 1) and either NLSSS or %NLSSS data (columns C and F, Table 1). Nor do these megasequence features seem to bear any relationship to divisions of the biostratigraphic column (far right column, Table 1). Nor do these megasequence features seem to bear relationship to 'mass extinction' events (column J, Ta-

ble 1). Although the Cretaceous/Paleogene ‘extinction’ event is close to the end of the Zuni megasequence, the largest ‘extinction’ event (that of the Permo-Triassic) has no special relation to the Absaroka megasequence in which it is found. The lack of correlation between megasequences and biostratigraphy is a curious phenomenon. It would seem that the sequence of burial of organisms was not at all affected by the changing energy levels of Flood waters. Whatever caused the remarkable boosts in energy required to explain these megasequences, did not affect the *order* of burial of organisms.

## SUMMARY AND CONCLUSION

Distinct NLSSS patterns and amplitudes suggest the earth’s stratigraphic column can be divided into five NLSSS biostratigraphic zones. The first zone includes the Precambrian and Cambrian, the second the Ordovician through all but the last stage of the Mississippian, the third the last stage of the Mississippian through the Permian, the fourth the Mesozoic and lowermost stage of the Cenozoic, and the fifth the Cenozoic above its lowest stage. The low stratigraphic position and the zero NLSSS values strongly suggest the pre-Flood/Flood boundary lies in the upper part of the first (Precambrian-Cambrian) zone. The high stratigraphic position and the very high NLSSS values strongly suggest the Flood/post-Flood boundary lies in the lower part of the fifth (Cenozoic) zone. This, in turn, suggests that the second, third, and fourth zones (Ordovician through Cretaceous) are Flood sediments. When the second and fourth zones are compared, the second zone’s lower stratigraphic position, similar NLSSS pattern, and lower amplitude NLSSS values suggest that the Ordovician through Mississippian sediments were deposited during the Flood’s early period of marine burial. The fourth zone was then deposited as the Flood was burying terrestrial organisms. This, in turn, suggests that the Pennsylvanian-Permian zone was deposited around the time that the Flood began to transgress onto the land. Dating the initial transgression to the Pennsylvanian-Permian offers a reasonable source for the world’s Permo-Triassic sands (pre-Flood coastal sands) and a reasonable explanation for the Carboniferous coals (beaching and breakup of the pre-Flood floating forest). All this means that to a first-order approximation, the five NLSSS biostratigraphic zones correspond to pre-Flood, early (‘marine’) Flood, initial land transgression, late (‘terrestrial’) Flood, and post-Flood, respectively.

More specifically on the position of the pre-Flood/Flood boundary, NLSSS values suggest a boundary somewhere between the Rhyacian/Orosirian boundary and the Cambrian/Ordovician boundary. The range of candidate boundaries indicated by NLSSS values includes the traditional Precambrian/Cambrian boundary popular among creationists from at least the time of Clark (1946). It also includes what can be considered the Tonian/Cryogenian refinement of the Precambrian/Cambrian boundary suggested by Austin and Wise (1994). More specifically on the position of the Flood/post-Flood boundary, NLSSS values argue very strongly against a boundary in the upper Cenozoic. As powerful as Ross’s (2012) criterion was against an upper Cenozoic Flood/post-Flood boundary in North America, this paper’s refinement of that criterion is even more definitive. For any potential boundary in the middle or upper Cenozoic, more than one hundred species of organisms—including land animals—would have to return to the same state- or province-sized

area where that species was buried in Flood sediments. The Flood/post-Flood boundary is most definitely not in the Upper Cenozoic. A Danian/Selandian boundary is suggested by global NLSSS data, and strongly confirmed by marine versus terrestrial NLSSS data in North America.

Beyond its use in distinguishing pre-Flood, Flood, and post-Flood sediments, NLSSS research provides insights into processes from each portion of earth history. In the Precambrian-Cambrian zone, for example, NLSSS data suggests a variety of different processes and/or process rates were involved in pre-Flood and possibly earliest Flood sedimentation. Low NLSSS values in the Precambrian-Cambrian zone also suggest that many of the Precambrian fossils were buried under catastrophic conditions—perhaps pointing to catastrophism during the Creation Week. Furthermore, if the pre-Flood/Flood boundary is anywhere near the Precambrian boundary, as is popularly believed, the many zero NLSSS values in the Cambrian suggests there is strong biozonation in the earliest Flood sediments.

Concerning biostratigraphy in general, the global biostratigraphic column seems to be real. However, sub-erathem biostratigraphic units show no relationship to known measures of biostratigraphic continuity. This suggests that index fossils and sub-erathem biostratigraphic units do not provide useful insight into earth history beyond giving us a relative time scale. Concerning lithostratigraphy in general, megasequences *sensu stricto* seem to be real phenomena. However, with the possible exception of the Cambrian, there may be no relationship between the litho- and bio-stratigraphic columns. This suggests that the order in which the Flood buried fossils bore no relationship to fluctuations in Flood energy. At the same time, strong fluctuations in NLSSS values indicate that the fossil record shows strong biozonation. These fluctuations may even be episodic. Such biozonation probably provides valuable information about both biogeography and burial processes before, during, and after the Flood.

This paper suggests a number of future research projects. For example, the Precambrian-Cambrian NLSSS zone should be re-evaluated at the genus and family levels. We believe this will provide an effective test of Austin and Wise’s (1994) hypothesis of the pre-Flood/Flood boundary at the Tonian/Cryogenian boundary. We believe it will also advance theories about the role of Creation Week versus antediluvian processes in generating Precambrian sediments. Combining such a reanalysis with lithologic data, will also determine if Wise’s explanation of biozonation at the edges of pre-Flood continents can be extended to explain the biostratigraphy of the entire Cambrian. Flood sediments should also be re-evaluated while teasing apart ‘true’ marine vs. floating forest vs. ‘true’ terrestrial organisms. This reanalysis should provide a test of both Wise’s (1994) floating forest hypothesis and this paper’s suggestion that the Flood transitioned from the oceans to the land sometime in the Pennsylvanian-Permian NLSSS biozone. The entire stratigraphic column should also be reanalyzed separating marine and terrestrial organisms. We expect such a reanalysis should provide another criterion for identifying both the pre-Flood/Flood and Flood/post-Flood boundaries. The latter study should be supplemented with a geologic study of the extensive Eurasian mountain system to test this paper’s claim that the marine sediments in those mountains were actually laid down in post-Flood continental shelf sediments (and raised by

later post-Flood orogeny to current altitudes).

We believe NLSSS data provide valuable information about earth history. Spawning several other follow-up projects, we also believe this paper's research is heuristic. And, since the NLSSS measure is only one paleontological measure among many, we also believe that the PBDB carries an enormous amount of untapped information for creationists. We encourage creationists to engage in the systematic mining of PBDB data.

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