GSA DATA REPOSITORY 2013017

Diversity trends in the establishment of terrestrial vertebrate ecosystems: interactions between spatial and temporal biases

Benson, R.B., and Upchurch, P.

APPENDIX DR1

EXTENDED JUSTIFICATION OF THE USE OF FORMATION COUNTS AS A SAMPLING PROXY

Benton (2012) presented counts of Permian tetrapod-bearing formations for statistical comparison with tetrapod taxic diversity as a test of fossil record reliability. We performed similar tests here and found different results for methodological reasons described in the main text. However, although formations and other lithostratigraphic units have been widely employed as a sampling proxy (e.g. Wignall & Benton 1999; Peters & Foote 2001, 2002; Crampton et al. 2003; Wang & Dodson 2006; Barrett et al. 2009; Peters & Heim 2010; Benson & Butler 2011; Upchurch et al 2011; and herein) and generally correlate with other measures of rock availability and sampling (Crampton et al. 2003; Peters 2005; Upchurch et al. 2011), Benton (2012) also cautioned against their use for three reasons, listed below. Each of these requires further consideration.

Reason 1

Formation counts may be statistically non-independent from taxic diversity if formations are defined on the basis of fossil occurrences (Benton 2012). This issue was discussed in slightly more detail by Benton et al. (2011, p. 70) who stated that: "if fossils are highly abundant and diverse, formations may be subdivided more finely than if fossils are sparse or absent. This means that formation counts are not necessarily independent of the signal they seek to test or correct".

Response to reason 1

In fact, in general, formations are defined on lithostratigraphic bases by geologists, and we doubt that definition of formations based on fossil content is common. Although some rock units may have been named or defined on the presence of a particular fossil type (e.g. the Mammal Bed of the Cretaceous Lulworth Formation, UK; Ensom 2002), most formally-defined formations are established on lithological grounds, and we know of no examples in which formation boundaries have been assigned based on evenly apportioning taxic diversity, which would be especially problematic.

A related problem termed 'redundancy' has also been proposed (reviewed by Benton et al. 2011; see also Upchurch and Barrett 2005), in which the use of a 'narrow' subset of formations, including only those which have yielded a particular kind of study taxon (e.g. anomodont- or pterosaur-bearing formations) might non-randomly underestimate opportunities to sample the diversity of that clade. In this situation, correlation between taxon counts and 'narrow' formation counts is due to circularity of definition rather than the presence of sampling bias. In other words, causality is reversed so that 'narrow' formation counts might be driven by the occurrences of the fossils they contain (e.g. anomodonts or pterosaurs). In our study, tests of statistical relationships between tetrapod-bearing formations (a 'wide' sampling proxy) and taxonomic subsets of Tetrapoda such as 'amphibians', may circumvent this problem. We also note that the redundancy hypothesis predicts that variation in 'corrected' diversity following sample-standardisation or modelling techniques will be essentially invariant, vary only within confidence intervals, or vary in a stochastic way that is not correlated with patterns in other clades or major events in Earth's history (Benton et al. 2011, p. 72). Among others, studies of anomodonts (Fröbisch 2008), pterosaurs (Butler et al. 2009), shallow marine tetrapods (Benson & Butler 2011), and sauropod dinosaurs (Benson & Mannion 2012) have demonstrated that cogent diversity patterns remain after 'correction' for formation counts. Critically, these patterns are similar to those suggested by alternative methods such as phylogenetic disparity estimation, and sample-standardisation (e.g. Mannion et al. 2011), and often include major, multi-clade events in Earth's history such as mass extinction events. Thus, the predictions of the redundancy hypothesis are contradicted by analyses of empirical data.

Reason 2

Excluding unfossiliferous formations may exclude important data on the absence of tetrapods in some facies or spatiotemporal regions. Counting only fossiliferous formations excludes instances where tetrapod fossils have been sought but not found, so sampling success and failure together are not being adequately captured by the sampling proxy regions, only success (Benton 2012).

Response to reason 2

Ideally all assessments of fossil record sampling would include some measure of 'failed' sampling attempts. Fossiliferous formation counts may not achieve this literally, although they do include formations yielding very few, or even a single fossil. Some measures of rock availability (e.g. rock outcrop area) may provide this benefit. However, they currently suffer from difficulties identifying when absence could be due to taphonomic factors, or the lack of an attempt to sample (e.g. Peters & Heim 2010), rather than the genuine absence of organisms in a particular facies or spatiotemporal region (e.g. McGowan & Smith 2008). Critically, regardless of these opposing theoretical issues with both fossiliferous formation counts and rock abundance measures, the two types of 'sampling proxy' ('rock amount' and formation counts) have generally been found to correlate in large datasets (Crampton et al. 2003; Peters 2005; Upchurch et al. 2011). This suggests that, although an 'ideal' sampling proxy is hard to find, many currently used metrics are largely adequate.

The most important question relevant to this issue is whether unfossiliferous formations should be considered an opportunity to sample ancient biodiversity. We suggest that the total absence of a widespread, ecologically diverse clade such as Tetrapoda in a lithostratigraphic unit is often more suggestive of taphonomic destruction, or a lack of sampling attempts, than the actual absence of organisms in a spatiotemporal region. If so, then fossiliferous formation counts should be an adequate appraisal of opportunities to sample ancient biodiversity.

Reason 3

Taxic diversity and rock availability measures such as formation counts may be correlated due to a third, common, causational factor such as sea level or climatic regime (the 'common cause' hypothesis). If this occurs, then 'correcting' observed taxic diversity for rock availability may eliminate genuine diversity signals (Peters 2005; discussed further by e.g. Smith 2007 ['biological hypothesis']; Benton et al. 2011).

Response to reason 3

The 'common cause' hypothesis, in which both sedimentary deposition and biodiversity of shallow marine organisms are driven by changes in sea level is pervasive in the shallow marine fossil record (e.g. Peters 2005; Benson & Butler 2011; Hannisdal & Peters 2011). Thus, mutual responses to interacting Earth systems, not sampling biases, explain much (but probably not all) of the observed covariation between Phanerozoic patterns of shallow marine sedimentation and fossil biodiversity (Hannisdal & Peters 2011).

However, there is currently no clear explanation of how climate, or any other common cause mechanism, might influence the global terrestrial fossil record. This is important because in the absence of a theoretical mechanism the common cause hypothesis is difficult, perhaps impossible, to test empirically. Nonetheless, two lines of evidence suggest that common cause effects might not be important determinants of observed terrestrial paleodiversity and rock deposition:

(i) The 'common cause' hypothesis implies that sampling proxies are driven by the same environmental factors that drove ancient biodiversity trends. Under this hypothesis then, 'sampling proxies' are effectively proxies for important environmental variables and should correlate with both observed paleodiversity, and plausibly also with sample-standardised paleodiversity. Irmis & Whiteside (2012) examined the correlation between Middle Permian-early Middle Triassic paleodiversity and rock record sampling proxies in Russia and South Africa. They found correlations using observed data, but a lack of correlation using sample-standardised (rarefied) paleodiversity. This lack of correlation suggests the absence of strong common cause effects. However, this result should be interpreted cautiously as sample-standardisation itself may remove genuine biodiversity signal imparted by environmental drivers (Hannisdal & Peters 2011).

(ii) Although sea level is an important driver of common cause effects in the shallow marine realm, and has been proposed as a potential driver in the terrestrial realm (reviewed by Butler et al. 2011), there is no statistically significant relationship between sea level and terrestrial record sampling proxies, or taxic diversity, in the most richly-sampled clade of Mesozoic tetrapods, the dinosaurs (Butler et al. 2011). There is also no correlation between observed tetrapod paleodiversity and sea level in a smaller dataset of Late Jurassic-Eocene continental tetrapods (Fara 2002).

For the reasons explained above, we conclude that although theoretical criticisms of formation counts, and other rock record based sampling proxies have been proposed (e.g. McGowan & Smith 2008; Benton et al. 2011; Benton 2012), empirical studies suggest that these are not fatally problematic, or might not apply to terrestrial datasets. This does not mean that our approach is completely free from error of all kinds. Indeed, we used 95% confidence intervals to accommodate uncertainty. One potential source of error is the uneven areal extent and vertical thickness of formally defined rock units (e.g. McGowan & Smith 2008; Benton et al. 2011). However, this should not be a serious issue so long as error is randomly distributed.

SERIAL CORRELATION IN TIME SERIES DATA

We calculated the strength of serial correlation in the data series using the 'ar' function of R version 2.10.1 (R Development Core Team 2009), which was used for all the statistical analyses described here. Serial correlation coefficients (a_n) describe the correlation of a time series with itself at a time lag of n stages. The presence of serial correlation in data series during statistical comparison procedures can artificially inflate the observed level of correlation and introduce Type I error. Thus, appropriate statistical techniques must be used to remove or account for serial correlation where it is present.

Statistically significant, non-zero serial correlation coefficients (a_n, where n is the time lag) were recovered at a time lag of one time bin for 'amphibian' taxic diversity (a_1=0.59), amniote taxic diversity (a_1=0.79), and tetrapod taxic diversity (a_1=0.56). Formation counts exhibit cyclicity with a period of four time bins. Thus, a_1=0.81 and a_2=-0.53.

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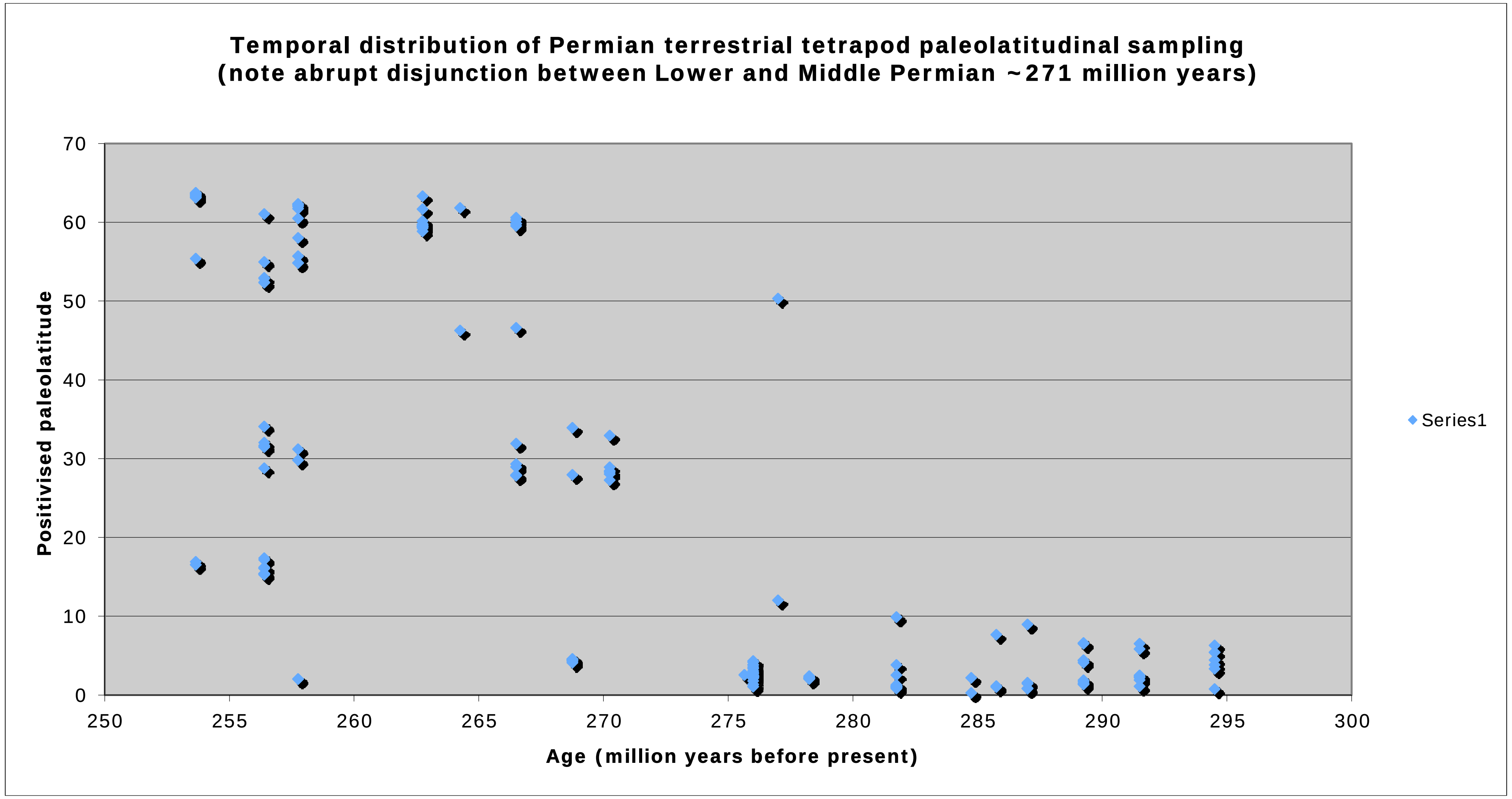
Appendix DR2 - Statistical Results

Sheet 2: Residual models: containing primary data series, and result and plots of residual diversity with confidence intervals
Sheet 3: Serial correlations: containing measured serial correlation coefficients based on the data series presented by Benton (2012)
Sheet 4: GLS analyses: containing detailed results of generalised least squares (GLS) multiple regression analyses
Sheet 5: PBDB 02 July 2012: Permian tetrapod collection download from Paleobiology Database (www.paleodb.org) 2nd July 2012. These data are plotted on the current sheet

Abbreviations	Modelled diversity estimate
MDE	Residual diversity estimate
RDE	
	Serial correlation coefficient at a time lag of one stage
ar1	Serial correlation coefficient at a time lag of two stages (only reported where statistically significant)
ar2	
	Multiple regression model with no autoregressive model (equivalent to ordinary least squares regression)
AR0	Multiple regression model with an autoregressive model or order 1
AR1	Multiple regression model with an autoregressive model or order 2
AR2	Serial correlation coefficient of austoregressive model at a time lag of one stage
Phi	Generalised coefficient of determination
R2	Aikake's information criterion modified for finite sample size
AICc	

Time scale	Gzhelian
GZE	Lower Asselian
ASS-l	Upper Asselian
ASS-u	Lower Sakmarian
SAK-l	Upper Sakmarian
SAK-u	Lower Artinskian
ART-l	Upper Artinskian
ART-u	Lower Kungurian
KUN-l	Upper Kungurian
KUN-u	Roadian
ROA	Wordian
WOR	Lower Capitanian
CAP-l	Upper Capitanian
CAP-u	Lower Wuchiapingian
WUC-l	Upper Wuchiapingian
WUC-u	Changhsingian
CHX	

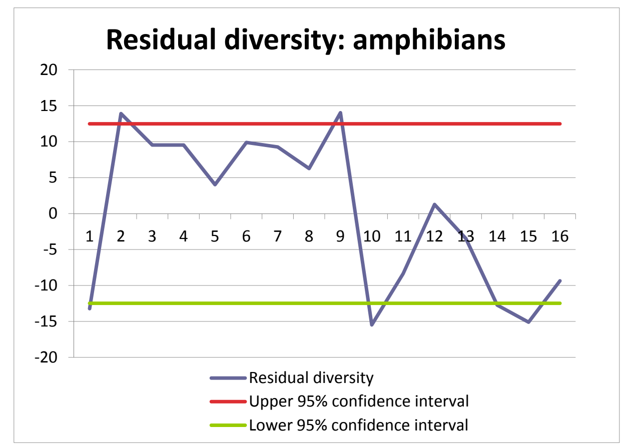

Temporal distribution of Permian terrestrial tetrapod paleolatitudinal sampling
(note abrupt disjunction between Lower and Middle Permian ~271 million years)
Positivised paleolatitude
Age (million years before present)
0
10
20
30
40
50
60
70
250
255
260
265
270
275
280
285
290
295
300
Series1

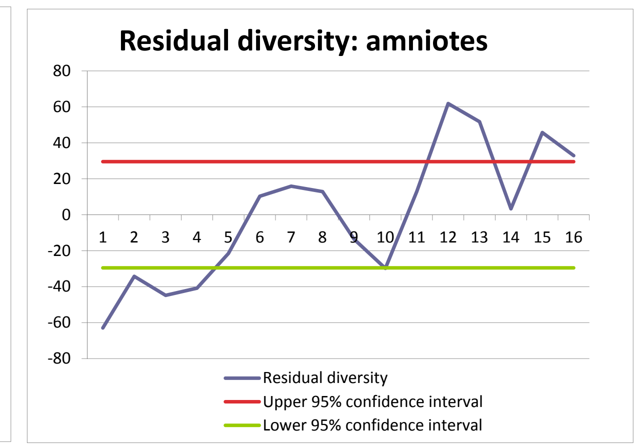
Data series

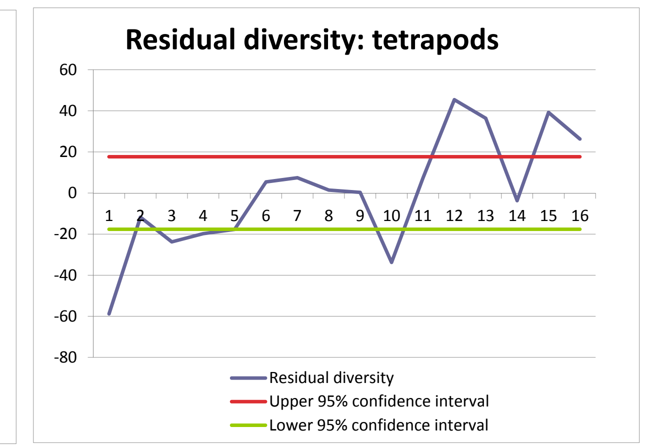
		Duration	Midpoint age from start	'Amphibian' diversity	Amniota diversity	Tetrapoda diversity	Formations
Cisularian	1 GZE	4.9	2.45	21	4	25	22
	2 ASS-l	2.8	6.3	41	16	57	19
	3 ASS-u	2.8	9.1	39	11	50	20
	4 SAK-l	5.1	13.05	39	15	54	20
	5 SAK-u	5.1	18.15	24	12	36	16
	6 ART-l	4.4	22.9	18	16	34	11
	7 ART-u	4.4	27.3	15	16	31	10
	8 KUN-l	2.5	30.75	12	13	25	10
	9 KUN-u	2.5	33.25	34	20	54	16
Guadalupian	10 ROA	2.5	35.75	14	26	40	20
	11 WOR	2.5	38.25	14	52	66	17
	12 CAP-l	2.5	40.75	7	62	69	10
	13 CAP-u	2.5	43.25	7	63	70	12
Lopingian	14 WUC-l	3	46	12	48	60	18
	15 WUC-u	3	49	12	96	108	19
	16 CHX	2	51.5	13	72	85	17

Residual diversity results

'Amphibians'				Amniotes				Tetrapods			
MDE	RDE	Upper 95%	Lower 95%	MDE	RDE	Upper 95%	Lower 95%	MDE	RDE	Upper 95%	Lower 95%
34.2182	-13.2182	12.4798433	-12.479843	66.9458	-62.9458	29.5454516	-29.545452	83.8104	-58.8104	17.6568893	-17.656889
27.0974	13.9026	12.4798433	-12.479843	50.2361	-34.2361	29.5454516	-29.545452	68.7483	-11.7483	17.6568893	-17.656889
29.471	9.529	12.4798433	-12.479843	55.806	-44.806	29.5454516	-29.545452	73.769	-23.769	17.6568893	-17.656889
29.471	9.529	12.4798433	-12.479843	55.806	-40.806	29.5454516	-29.545452	73.769	-19.769	17.6568893	-17.656889
19.9766	4.0234	12.4798433	-12.479843	33.5264	-21.5264	29.5454516	-29.545452	53.6862	-17.6862	17.6568893	-17.656889
8.1086	9.8914	12.4798433	-12.479843	5.6769	10.3231	29.5454516	-29.545452	28.5827	5.4173	17.6568893	-17.656889
5.735	9.265	12.4798433	-12.479843	0.107	15.893	29.5454516	-29.545452	23.562	7.438	17.6568893	-17.656889
5.735	6.265	12.4798433	-12.479843	0.107	12.893	29.5454516	-29.545452	23.562	1.438	17.6568893	-17.656889
19.9766	14.0234	12.4798433	-12.479843	33.5264	-13.5264	29.5454516	-29.545452	53.6862	0.3138	17.6568893	-17.656889
29.471	-15.471	12.4798433	-12.479843	55.806	-29.806	29.5454516	-29.545452	73.769	-33.769	17.6568893	-17.656889
22.3502	-8.3502	12.4798433	-12.479843	39.0963	12.9037	29.5454516	-29.545452	58.7069	7.2931	17.6568893	-17.656889
5.735	1.265	12.4798433	-12.479843	0.107	61.893	29.5454516	-29.545452	23.562	45.438	17.6568893	-17.656889
10.4822	-3.4822	12.4798433	-12.479843	11.2468	51.7532	29.5454516	-29.545452	33.6034	36.3966	17.6568893	-17.656889
24.7238	-12.7238	12.4798433	-12.479843	44.6662	3.3338	29.5454516	-29.545452	63.7276	-3.7276	17.6568893	-17.656889
27.0974	-15.0974	12.4798433	-12.479843	50.2361	45.7639	29.5454516	-29.545452	68.7483	39.2517	17.6568893	-17.656889
22.3502	-9.3502	12.4798433	-12.479843	39.0963	32.9037	29.5454516	-29.545452	58.7069	26.2931	17.6568893	-17.656889







			Duration	Midpoint age from start	'Amphibian' diversity	Amniota diversity	Tetrapoda diversity	Formations		Diversity simulating 'Olson's Gap'	Formations simulating 'Olson's Gap'
Cisularian	1	GZE	4.9	2.45	21	4	25	22		25	22
	2	ASS-l	2.8	6.3	41	16	57	19		57	19
	3	ASS-u	2.8	9.1	39	11	50	20		50	20
	4	SAK-l	5.1	13.05	39	15	54	20		54	20
	5	SAK-u	5.1	18.15	24	12	36	16		36	16
	6	ART-l	4.4	22.9	18	16	34	11		34	11
	7	ART-u	4.4	27.3	15	16	31	10		31	10
	8	KUN-l	2.5	30.75	12	13	25	10		25	10
	9	KUN-u	2.5	33.25	34	20	54	16		66	19
Guadalupian	10	ROA	2.5	35.75	14	26	40	20		0	0
	11	WOR	2.5	38.25	14	52	66	17		82	22
	12	CAP-l	2.5	40.75	7	62	69	10		69	10
	13	CAP-u	2.5	43.25	7	63	70	12		70	12
Lopingian	14	WUC-l	3	46	12	48	60	18		60	18
	15	WUC-u	3	49	12	96	108	19		108	19
	16	CHX	2	51.5	13	72	85	17		85	17
				Serial correlation:	ar1=0.5881	ar1=0.713	ar1=0.4534	ar1=0.8067; ar2=-0.5311		ar1=0.16 (not significan	ar1=-0.15 (not signficant)

Model (explanatory variables)	**N**	**AICc** AR0	AR1	**Phi** AR1	**TBF** Coefficient	p-value	**Phase/age** Coefficient	p-value	**Log-likelihood**	**Jarque-bera** (normality test)	**R2**	**Best AICc**	**Delta AICc**		**AICc weight**
Tetrapoda															
1	16	143.866	138.9388	0.7239989					-66.00787	0.5118		138.9388	1.5909	0.45137807	0.189463923
TBF	16	143.9726	139.4259	0.7207541	0.09172	0.9514			-64.71294	0.5118	0.14944504	139.4259	2.078	0.35380831	0.148509455
age	16	139.8693	138.447	0.5160869			0.982821	0.0632	-64.2235	0.853	0.19992216	138.447	1.0991	0.5772095	0.242281101
TBF+age	16	137.3479	138.7825	0.2862839	2.284113	0.0518	1.105487	0.0017	-62.85575	0.8732	0.32565606	137.3479	0	1	0.419745521
														2.38239588	
dur	16	137.6965	136.1063	0.5795557					-63.05314	0.2853		136.1063	0	1	0.306801417
TBF+dur	16	138.0738	136.9454	0.5620442	0.59136	0.7036			-61.6545	0.3129	0.16040026	136.9454	0.8391	0.65734256	0.201673628
age+dur	16	137.8002	136.6969	0.4984955			0.88408	0.1361	-61.53026	0.9323	0.17333852	136.6969	0.5906	0.74430826	0.228354829
TBF+age+dur	16	136.4131	137.6507	0.3092094	2.2181442	0.0683	0.9947231	0.0187	-60.20656	0.9076	0.29940303	136.4131	0.3068	0.85778654	0.263170126
														3.25943736	
Minus bins 10 and 14															
1	14	119.6872	127.1986	0.8836447					-61.05384	0.6221		119.6872	4.8037	0.09055028	0.060015618
TBF	14	127.1704	117.2739	1	2.364103	0.0713			-53.43695	0.8736	0.66315323	117.2739	2.3904	0.30264342	0.200588357
age	14	123.006	119.199	0.7096197			1.177731	0.0862	-54.39951	0.9087	0.61349813	119.199	4.3155	0.11558489	0.076608255
TBF+age	14	114.8835	116.1468	0.3780121	3.51486	0.0023	1.41303	0.0001	-51.21951	0.6872	0.75460946	114.8835	0	1	0.66278777
														1.50877859	
dur	14	120.8598	117.9052	0.8224018					-53.75259	0.5726		117.9052	2.9952	0.22366632	0.113040494
TBF+dur	14	120.6628	116.0621	1	2.587149	0.0681			-50.80881	0.8852	0.34330789	116.0621	1.1521	0.56211434	0.284091426
age+dur	14	121.1316	118.2016	0.6982971			1.17984	0.1153	-51.87856	0.9057	0.23487692	118.2016	3.2916	0.19285821	0.097470144
TBF+age+dur	14	114.91	116.0908	0.3628131	3.439688	0.0038	1.287141	0.0016	-48.70502	0.6361	0.51377385	114.91	0	1	0.505397936
														1.97863887	
Amniotes															
1	16	149.7369	133.963	1					-63.51996	0.3342		133.963	0.9442	0.62369114	0.244886467
TBF	16	149.7855	134.6211	0.9883519	-0.60312	0.6215			-62.31056	0.3084	0.14030276	134.6211	1.6023	0.44881253	0.176222025
age	16	135.7218	133.0188	0.6012608			1.407584	0.0086	-61.50938	0.841	0.2222285	133.0188	0	1	0.392640606
TBF+age	16	135.3892	134.5104	0.5972231	0.130963	0.9133	1.422304	0.0126	-60.43702	0.84	0.31979938	134.5104	1.4916	0.47435466	0.186250903
														2.54685834	
dur	16	142.5139	132.2453	1					-61.12265	0.3387		132.2453	0.487	0.78387948	0.302497829
TBF+dur	16	143.4416	133.3064	0.9969267	-0.65764	0.6165			-59.83504	0.3278	0.14866643	133.3064	1.5481	0.46114166	0.177953824
age+dur	16	134.3559	131.7583	0.6014262			1.446938	0.017	-59.06098	0.8171	0.22717972	131.7583	0	1	0.385898392
TBF+age+dur	16	134.8463	133.879	0.6136147	0.06023	0.9623	1.45034	0.0255	-57.93948	0.8138	0.32826828	133.879	2.1207	0.34633457	0.133649954
														2.59135571	
Minus bins 10 and 14															
1	14	132.3872	114.9707	1					-53.93989	0.3545		114.9707	1.8814	0.39035449	0.143377864
TBF	14	132.4588	115.0382	1	1.210256	0.288			-52.31909	0.4535	0.2066913	115.0382	1.9489	0.37739987	0.138619608
age	14	119.1673	113.0893	0.8299859			1.610565	0.0251	-51.34467	0.8985	0.30978057	113.0893	0	1	0.367301689
TBF+age	14	115.3701	113.1818	0.6865556	1.50211	0.1449	1.71136	0.0032	-49.36866	0.919	0.47953511	113.1818	0.0925	0.95480323	0.350700839
														2.72255759	
dur	14	125.4791	113.4559	1					-51.52793	0.3793		113.4559	1.4013	0.49626263	0.218489677
TBF+dur	14	126.5985	114.3649	1	1.159931	0.3483			-49.96025	0.4525	0.20064832	114.3649	2.3103	0.31501028	0.138689659
age+dur	14	118.1305	112.0546	0.8592842			1.77557	0.0296	-48.80508	0.745	0.32225121	112.0546	0	1	0.44027026

TBF+age+dur	14	115.8257	113.6074	0.7131391	1.38606	0.2073	1.77432	0.0069	-47.05368	0.8559	0.47227426	113.6074	1.5528	0.46005925	0.202550404
														2.27133216	
'Amphibians'															
1	16	124.069	118.1918	0.6632219					-55.63438	0.3428		118.1918	5.7759	0.05569026	0.034066558
TBF	16	121.9136	118.6167	0.602901	0.889798	0.2247			-54.30836	0.3725	0.1527441	118.6167	6.2008	0.04503119	0.027546244
age	16	117.399	119.0589	0.2027192			-0.55153	0.001	-54.69952	0.7805	0.11028803	117.399	4.9831	0.08278156	0.050638705
TBF+age	16	118.0541	120.05	-0.0289043	0.816129	0.1322	-0.482219	0.0032	-53.20889	0.6451	0.26153845	118.0541	5.6382	0.05965961	0.03649467
phase	16	114.4496	114.291	0.4547733			-10.43209	0.1614	-52.14552	0.4249	0.35345178	114.291	1.8751	0.39158605	0.239538992
TBF+phase	16	112.4159	114.4159	-0.0035505	1.227649	0.0305	-13.761783	0.0059	-50.38978	0.846	0.48085653	112.4159	0	1	0.61171483
														1.63474866	
dur	16	122.015	117.3318	0.7025393					-53.66588	0.3947		117.3318	4.1927	0.12290421	0.05550996
TBF+dur	16	120.8328	118.0013	0.6960195	0.982403	0.2106			-52.18248	0.4295	0.16924886	118.0013	4.8622	0.08794005	0.039718317
age+dur	16	116.0404	117.762	0.1769108			-0.67191	0.0014	-52.20201	0.8073	0.16721831	116.0404	2.9013	0.23441787	0.105875351
TBF+age+dur	16	117.79	119.7373	0.09770021	0.75155	0.1661	-0.59065	0.0043	-50.89502	0.8265	0.2927404	117.79	4.6509	0.09773945	0.044144241
phase+dur	16	114.2574	113.9368	0.4820639			-10.896421	0.1917	-50.15023	0.489	0.35561329	113.9368	0.7977	0.67109136	0.303099905
TBF+phase+dur	16	113.1391	115.0455	0.1352785	1.239883	0.0357	-14.756182	0.0125	-48.56953	0.6799	0.47114646	113.1391	0	1	0.451652225
														2.21409293	
Minus bins 10 and 14															
1	14	109.6785	105.3542	0.6486671					-49.13166	0.4563		105.3542	9.81514	0.00739043	0.005782731
TBF	14	106.1221	104.8454	0.5599888	1.2388606	0.1169			-47.22269	0.52	0.23868646	104.8454	9.30634	0.00953134	0.007457917
age	14	105.2531	106.8253	0.2490494			-0.55152	0.0033	-48.42653	0.7457	0.09582546	105.2531	9.71404	0.00777361	0.006082563
TBF+age	14	105.6115	107.5865	0.07890102	1.025326	0.1066	-0.434279	0.0169	-46.58354	0.6276	0.30512072	105.6115	10.07244	0.00649827	0.00508465
phase	14	100.1831	98.33723	0.5543244			-17.2045	0.0429	-43.96861	0.729	0.52172939	98.33723	2.79817	0.2468227	0.193129535
TBF+phase	14	95.53906	97.46182	0.1548168	1.530172	0.0064	-14.869828	0.0029	-41.54731	0.563	0.66158373	95.53906	0	1	0.782462604
														1.27801635	
dur	14	108.1061	104.5996	0.6881824					-47.09979	0.5005		104.5996	9.63253	0.00809697	0.006423043
TBF+dur	14	106.04	104.3713	0.703535	1.381159	0.1071			-44.96344	0.519	0.26301877	104.3713	9.40423	0.00907606	0.007199719
age+dur	14	104.1093	105.8387	0.1921339			-0.6874	0.0037	-45.8324	0.8035	0.16561113	104.1093	9.14223	0.01034642	0.008207448
TBF+age+dur	14	105.8584	107.6628	0.2205922	0.951424	0.1339	-0.558042	0.0155	-44.17918	0.7842	0.34113064	105.8584	10.89133	0.00431497	0.003422913
phase+dur	14	99.74459	97.91707	0.549732			-19.208	0.0355	-41.73631	0.9243	0.53522945	97.91707	2.95	0.22877873	0.181482105
TBF+phase+dur	14	94.96707	96.53316	0.2862476	1.624554	0.0037	-18.946213	0.0017	-38.73354	0.5547	0.6973501	94.96707	0	1	0.793264771
														1.26061315	

collection_no	Example genus name	Country	Modern day latitude	Modern day longitude	Early (1), Middle (2) or Late (3) Permian for terrestrial tetrapods only	Positivised paleolatitude	Paleolatitude	Paleolongitude	epoch	stage	10_my_bin	max_interval	min_interval	ma_mid	formation	member	environment
28324	Cricotus	United States	33.595556	-98.625278	1	0.28	-0.28	-29.46	Cisuralian			Sakmarian	Artinskian	284.75			terrestrial indet.
80777	Haptodus	France	46.984167	4.302778	1	0.78	0.78	17.49	Cisuralian	Asselian	Permian 1	Autunian		294.5			terrestrial indet.
28120	Eryops	United States	33.595556	-98.625278	1	0.83	-0.83	-29.74	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Putnam		terrestrial indet.
28121	Ophiacodon	United States	33.595556	-98.625278	1	0.83	-0.83	-29.74	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Putnam		terrestrial indet.
28122	Cricotus	United States	33.595556	-98.625278	1	0.83	-0.83	-29.74	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Putnam		terrestrial indet.
28123	Dimetrodon	United States	33.595556	-98.625278	1	0.83	-0.83	-29.74	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Putnam		terrestrial indet.
28124	Cricotus	United States	33.595556	-98.625278	1	0.83	-0.83	-29.74	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Putnam		terrestrial indet.
28125	Eryops	United States	33.595556	-98.625278	1	0.83	-0.83	-29.74	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Putnam		terrestrial indet.
28141	Ophiacodon	United States	33.595556	-98.625278	1	0.85	0.85	-28.86	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Admiral		terrestrial indet.
28119	Eryops	United States	33.473056	-98.764722	1	0.87	-0.87	-29.9	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Archer City		terrestrial indet.
85112	Protocaptorhinus	United States	33.566667	-98.933333	1	0.96	0.96	-29.1	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Petrolia		terrestrial indet.
13080	Eryops	United States	33.6225	-98.856944	1	0.97	0.97	-29.01	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Admiral		terrestrial indet.
28150	Ophiacodon	United States	33.601389	-98.920833	1	0.98	0.98	-29.07	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Admiral		terrestrial indet.
13044	Araeoscelis	United States	33.611667	-98.933611	1	1	1	-29.07	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Nocona		terrestrial indet.
80720	Baldwinonus	United States	39.766667	-80.933333	1	1.01	-1.01	-14.07	Cisuralian			Cisuralian		285.75			terrestrial indet.
84716	Ophiacodon	United States	33.641667	-98.9	1	1.01	1.01	-29.04	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Petrolia		terrestrial indet.
22668	Acheloma	United States	33.6333	-98.95	1	1.02	1.02	-29.08	Cisuralian	Artinskian	Permian 2	Artinskian		281.75			terrestrial indet.
22669	Parioxys	United States	33.6333	-98.95	1	1.02	1.02	-29.08	Cisuralian	Artinskian	Permian 2	Artinskian		281.75			terrestrial indet.
80741	Captorhinus	United States	33.666667	-98.966667	1	1.06	1.06	-29.07	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Petrolia		terrestrial indet.
28142	Diadectes	United States	33.816111	-98.694722	1	1.07	1.07	-28.8	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Admiral		terrestrial indet.
28239	Eryops	United States	33.816111	-98.694722	1	1.07	1.07	-28.8	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Admiral		terrestrial indet.
27133	Carrolla	United States	33.740278	-98.901944	1	1.09	1.09	-28.99	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
28143	Trimerorhachis	United States	33.740278	-98.901944	1	1.09	1.09	-28.99	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
28146	Ctenospondylus	United States	33.740278	-98.901944	1	1.09	1.09	-28.99	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
28238	Diadectes	United States	33.740278	-98.901944	1	1.09	1.09	-28.99	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
28240	Cricotus	United States	33.740278	-98.901944	1	1.09	1.09	-28.99	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
67735	Trimerorhachis	United States	32.13	-99.75	1	1.09	1.09	-29.91	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		delta plain
67737	Dimetrodon	United States	32.13	-99.75	1	1.09	1.09	-29.91	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		coarse channel fill
28144	Eryops	United States	33.687222	-99.022778	1	1.1	1.1	-29.1	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
28145	Eryops	United States	33.687222	-99.022778	1	1.1	1.1	-29.1	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Petrolia		terrestrial indet.
28148	Eryops	United States	33.687222	-99.022778	1	1.1	1.1	-29.1	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
34797	Actinodon	France	46.466667	2.966667	1	1.13	1.13	17.29	Cisuralian		Permian 1	Asselian	Sakmarian	291.5			terrestrial indet.
80576	Casea	France	44.45	2.433333	1	1.16	1.16	18.37	Cisuralian			Cisuralian		285.75			terrestrial indet.
28147	Eryops	United States	33.867222	-98.843889	1	1.18	1.18	-28.88	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
28149	Eryops	United States	33.891944	-98.812222	1	1.19	1.19	-28.85	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Belle Plains		terrestrial indet.
22714	Trimerorhachis	United States	34.126	-98.6216	1	1.31	1.31	-28.59	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Bead Mountain		terrestrial indet.
68171	Varanops	United States	32.45	-99.73	1	1.35	1.35	-29.74	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
79162	Eryops	United States	33.583333	-98.65	1	1.38	-1.38	-30.06	Cisuralian			Wolfcamp		289.25	Archer City		terrestrial indet.
13048	Broiliellus	United States	33.826389	-98.147778	1	1.39	-1.39	-29.57	Cisuralian			Wolfcamp		289.25			terrestrial indet.
84715	Romeria	United States	33.608333	-98.433333	1	1.45	-1.45	-29.89	Cisuralian			Wolfcamp		289.25	Putnam		terrestrial indet.
94802	Ophiacodon	United States	39.713889	-81	1	1.46	-1.46	-14.38	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Greene		terrestrial indet.
80723	Stereophallodon	United States	33.566667	-98.433333	1	1.48	-1.48	-29.91	Cisuralian			Wolfcamp		289.25	Pueblo		terrestrial indet.
80877	Ctenospondylus	United States	39.725	-80.9	1	1.48	-1.48	-14.3	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Greene	Niniveh Limes	terrestrial indet.
28466	Eryops	United States	39.725833	-80.4825	1	1.59	-1.59	-14	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Greene		lacustrine indet.
22635	Eryops	United States	33.34	-98.39	1	1.7	-1.7	-30	Cisuralian			Wolfcamp		289.25	Archer City		"channel"
22716	Diplocaulus	United States	32.9424	-99.7713	1	1.8	1.8	-29.52	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		"channel"
127110	Zatrachys	United States	40.045556	-80.651389	1	1.9	-1.9	-14.31	Cisuralian			Wolfcamp		289.25	Washington	middle	terrestrial indet.
28394	Zatrachys	United States	34.874167	-97.049722	1	1.93	-1.93	-28.82	Cisuralian			Wolfcamp	Sakmarian	291.5			terrestrial indet.
28241	Diplocaulus	United States	33.816111	-98.694722	1	2.04	2.04	-28.32	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Waggoner Ranch		terrestrial indet.
28242	Broiliellus	United States	33.687222	-99.022778	1	2.07	2.07	-28.62	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Waggoner Ranch		terrestrial indet.
28249	Ophiacodon	United States	33.687222	-99.022778	1	2.07	2.07	-28.62	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Waggoner Ranch		terrestrial indet.
85341	Protocaptorhinus	United States	33.75	-99.016667	1	2.12	2.12	-28.58	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Petrolia/Waggoner Ranch		terrestrial indet.
28250	Araeoscelis	United States	33.733333	-99.091667	1	2.13	2.13	-28.64	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Waggoner Ranch		terrestrial indet.
71671	Mycterosaurus	United States	33.733333	-99.091667	1	2.13	2.13	-28.64	Cisuralian		Permian 2	Artinskian	Kungurian	278.25			terrestrial indet.
28272	Eryops	United States	33.594167	-99.26	1	2.16	2.16	-28.83	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
28276	Lysorophus	United States	33.594167	-99.26	1	2.16	2.16	-28.83	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
28277	Ophiacodon	United States	33.594167	-99.26	1	2.16	2.16	-28.83	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
36571	Cacops	United States	33.602222	-99.257778	1	2.16	2.16	-28.83	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		terrestrial indet.
85299	Captorhinus	United States	33.746389	-99.119444	1	2.16	2.16	-28.66	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Lueders	Maybelle lime	lagoonal/restricted shallow
80690	Ophiacodon	United States	33.669722	-99.139444	1	2.17	2.17	-28.71	Cisuralian	Kungurian	Permian 2	Leonard		276	Waggoner Ranch		terrestrial indet.

85300	Phlegethontia	United States	33.751389	-99.145833	1	2.17	2.17	-28.67	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Lueders	Maybelle lime	shallow subtidal indet.
28252	Dimetrodon	United States	33.755	-99.145	1	2.18	2.18	-28.67	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Waggoner Ranch		terrestrial indet.
28253	Eryops	United States	33.755	-99.145	1	2.18	2.18	-28.67	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Waggoner Ranch		terrestrial indet.
80732	Ophiacodon	United States	37.233333	-96.983333	1	2.2	2.2	-26.48	Cisuralian			Sakmarian	Artinskian	284.75	Barneston Lir	Fort Riley Lim	marine indet.
85301	Eryops	United States	33.784167	-99.138889	1	2.2	2.2	-28.65	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Lueders	Maybelle lime	lacustrine indet.
11165	Archeria	United States	33.683333	-98.7	1	2.23	-2.23	-30.61	Cisuralian		Permian 1	Asselian	Sakmarian	291.5	Nocona		"floodplain"
28251	Labidosaurus	United States	33.755	-99.145	1	2.25	2.25	-28.67	Cisuralian	Kungurian	Permian 2	Kungurian		276	Waggoner Ranch		terrestrial indet.
28261	Diplocaulus	United States	33.755	-99.145	1	2.25	2.25	-28.67	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
28266	Dissorophus	United States	33.755	-99.145	1	2.25	2.25	-28.67	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
28267	Diplocaulus	United States	33.7	-99.266667	1	2.25	2.25	-28.78	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
28270	Dimetrodon	United States	33.714722	-99.312778	1	2.28	2.28	-28.81	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
28256	Captorhinus	United States	33.766667	-99.216667	1	2.29	2.29	-28.71	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
28264	Captorhinus	United States	33.755833	-99.233333	1	2.29	2.29	-28.73	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
85950	Captorhinus	United States	34.013889	-98.915	1	2.3	2.3	-28.38	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Waggoner Ranch		terrestrial indet.
22646	Captorhinus	United States	33.7833	-99.2333	1	2.31	2.31	-28.72	Cisuralian	Kungurian	Permian 2	Kungurian		276			terrestrial indet.
22670	Seymouria	United States	33.7833	-99.2333	1	2.31	2.31	-28.72	Cisuralian	Kungurian	Permian 2	Kungurian		276			terrestrial indet.
22671	Dissorophus	United States	33.7833	-99.2333	1	2.31	2.31	-28.72	Cisuralian	Kungurian	Permian 2	Kungurian		276			terrestrial indet.
85342	Captorhinus	United States	33.75	-99.316667	1	2.31	2.31	-28.8	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
13046	Broiliellus	United States	33.809722	-99.2	1	2.32	2.32	-28.68	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
22715	Captorhinus	United States	33.7977	-99.2369	1	2.32	2.32	-28.71	Cisuralian	Kungurian	Permian 2	Kungurian		276			terrestrial indet.
28273	Trimerorhachis	United States	33.733056	-99.359444	1	2.32	2.32	-28.83	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
85556	Labidosaurikos	United States	33.736944	-99.406667	1	2.34	2.34	-28.87	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		terrestrial indet.
91038	Gerobatrachus	United States	33.736944	-99.406667	1	2.34	2.34	-28.87	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo or Vale		terrestrial indet.
113555	Rubeostratilia	United States	33.816667	-98.2	1	2.34	-2.34	-30.18	Cisuralian		Permian 1	Asselian	Sakmarian	291.5	Nocona		terrestrial indet.
85125	Labidosaurikos	United States	33.760278	-99.371667	1	2.35	2.35	-28.83	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		terrestrial indet.
85550	Dimetrodon	United States	33.6675	-99.571111	1	2.35	2.35	-29.02	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale	"Bullwagon"	coarse channel fill
85552	Captorhinus	United States	33.665	-99.575833	1	2.35	2.35	-29.03	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale	"Bullwagon"	coarse channel fill
85551	Diplocaulus	United States	33.676111	-99.576944	1	2.36	2.36	-29.02	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale	"Bullwagon"	coarse channel fill
12976	Edaphosaurus	United States	33.703333	-99.6	1	2.39	2.39	-29.02	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale	"Bullwagon"	dry floodplain
27704	Trimerorhachis	United States	33.731667	-99.557778	1	2.4	2.4	-28.98	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		"channel"
27705	Labidosaurikos	United States	33.721111	-99.585556	1	2.4	2.4	-29	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		terrestrial indet.
79813	Captorhinus	United States	34.008333	-98.966667	1	2.4	2.4	-28.42	Cisuralian	Kungurian	Permian 2	Leonard		276	Waggoner Ranch		terrestrial indet.
85553	Diplocaulus	United States	33.721667	-99.574444	1	2.4	2.4	-29	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale	"Bullwagon"	coarse channel fill
85554	Dimetrodon	United States	33.737222	-99.586944	1	2.41	2.41	-29	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale	"Bullwagon"	coarse channel fill
90452	Peronedon	United States	33.783611	-99.475	1	2.41	2.41	-28.89	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		lacustrine - small
85555	Diplocaulus	United States	33.7575	-99.548611	1	2.42	2.42	-28.96	Cisuralian	Kungurian	Permian 2	Kungurian		276	Vale		coarse channel fill
85733	Dimetrodon	United States	34.295833	-98.598611	1	2.42	2.42	-28.01	Cisuralian		Permian 2	Artinskian	Kungurian	278.25	Garber		terrestrial indet.
28275	Diplocaulus	United States	33.973056	-99.195556	1	2.46	2.46	-28.6	Cisuralian	Kungurian	Permian 2	Kungurian		276	Arroyo		terrestrial indet.
79601	Captorhinikos	United States	33.816667	-99.558333	1	2.47	2.47	-28.94	Cisuralian	Kungurian	Permian 2	Leonard		276	Choza		pond
85361	Captorhinikos	United States	33.816667	-99.558333	1	2.47	2.47	-28.94	Cisuralian	Kungurian	Permian 2	Leonard		276	Choza		terrestrial indet.
85362	Captorhinikos	United States	33.816667	-99.558333	1	2.47	2.47	-28.94	Cisuralian	Kungurian	Permian 2	Leonard		276	Choza		"channel"
67945	Trimerorhachis	United States	34.189722	-98.787778	1	2.48	2.48	-28.2	Cisuralian	Kungurian	Permian 2	Kungurian		276	Hennessey		fluvial indet.
22667	Parioxys	United States	33.44	-98.54	1	2.51	-2.51	-30.62	Cisuralian		Permian 1	Asselian	Sakmarian	291.5	Belle Plains		
80574	Casea	United States	33.85	-99.633333	1	2.53	2.53	-28.98	Cisuralian	Kungurian	Permian 2	Leonard		276	Choza		terrestrial indet.
79402	Edaphosaurus	United States	36.161667	-97.340556	1	2.55	2.55	-26.67	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Wellington		terrestrial indet.
87092	Captorhinikos	United States	35.141667	-97.358333	1	2.75	2.75	-26.71	Cisuralian	Kungurian	Permian 2	Kungurian		276	Hennessey		terrestrial indet.
79531	Captorhinikos	United States	35.169444	-97.368611	1	2.78	2.78	-26.7	Cisuralian	Kungurian	Permian 2	Kungurian		276	Hennessey	Fairmont Sha	fluvial-lacustrine indet.
67862	Mycterosaurus	United States	34.770556	-98.403889	1	2.84	2.84	-27.64	Cisuralian	Kungurian	Permian 2	Leonard		276	Garber		fissure fill
87091	Captorhinikos	United States	35.233333	-97.433333	1	2.86	2.86	-26.72	Cisuralian	Kungurian	Permian 2	Kungurian		276	Hennessey		terrestrial indet.
80691	Captorhinus	United States	34.955278	-98.615278	1	3.08	3.08	-27.7	Cisuralian	Kungurian	Permian 2	Leonard		276			fissure fill
79163	Protorothyris	United States	33.449722	-98.7775	1	3.35	-3.35	-31.38	Cisuralian	Asselian	Permian 1	Asselian		294.5	Archer City		terrestrial indet.
80578	Cotylorhynchus	United States	35.798333	-97.475833	1	3.37	3.37	-26.48	Cisuralian	Kungurian	Permian 2	Kungurian		276	Hennessey		terrestrial indet.
79602	Labidosaurikos	United States	35.95	-97.583333	1	3.55	3.55	-26.48	Cisuralian	Kungurian	Permian 2	Kungurian		276	Hennessey		terrestrial indet.
48897	Bathygnathus	Canada	46.516667	-63.516667	1	3.83	3.83	0.51	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Orby Head		terrestrial indet.
85451	Batropetes	Germany	49.578056	7.696111	1	3.83	3.83	19.09	Cisuralian	Asselian	Permian 1	Asselian		294.5	Lauterecken-	Jeckenbach	lacustrine - large
79408	Dictybolos	United States	36.35	-97.433333	1	3.84	3.84	-26.18	Cisuralian	Kungurian	Permian 2	Leonard		276	Wellington		lacustrine indet.
84941	Dictybolos	United States	36.35	-97.433333	1	3.84	3.84	-26.18	Cisuralian	Kungurian	Permian 2	Leonard		276	Wellington		lacustrine indet.
85567	Trimerorhachis	United States	36.35	-97.433333	1	3.84	3.84	-26.18	Cisuralian	Kungurian	Permian 2	Leonard		276	Wellington		mire/swamp
28067	Eryops	United States	35.716667	-106.78333	1	4.12	4.12	-34.43	Cisuralian			Wolfcamp		289.25	Abo/Cutler		fluvial indet.
79815	Captorhinus	United States	36.738611	-97.417778	1	4.18	4.18	-25.99	Cisuralian	Kungurian	Permian 2	Leonard		276	Wellington	McCann Sand	fluvial-deltaic indet.
87054	Bolosaurus	United States	36.766667	-97.766667	1	4.33	4.33	-26.22	Cisuralian	Kungurian	Permian 2	Leonard		276	Garber		terrestrial indet.
80130	Diasparactus	United States	36.283333	-106.35694	1	4.37	4.37	-33.82	Cisuralian			Wolfcamp		289.25	Abo/Cutler		fluvial indet.
80770	Edaphosaurus	United States	36.161667	-106.65	1	4.41	4.41	-34.08	Cisuralian			Wolfcamp		289.25	Abo/Cutler		terrestrial indet.

80916	Sphenacodon	United States	36.162222	-106.65028	1	4.41	4.41	-34.08	Cisuralian			Wolfcamp		289.25	Abo/Cutler		terrestrial indet.
85433	Ophiacodon	United States	36.162222	-106.65056	1	4.41	4.41	-34.08	Cisuralian			Wolfcamp		289.25	Abo/Cutler		terrestrial indet.
80833	Sphenacodon	United States	36.184722	-106.67139	1	4.44	4.44	-34.08	Cisuralian			Wolfcamp		289.25	Abo/Cutler		terrestrial indet.
85337	Ophiacodon	United States	36.178611	-106.67389	1	4.44	4.44	-34.09	Cisuralian			Wolfcamp		289.25	Abo/Cutler		terrestrial indet.
85178	Protorothyris	United States	39.720278	-80.210833	1	4.46	-4.46	-15.24	Cisuralian	Asselian	Permian 1	Asselian		294.5	Washington	Upper Mariett	lacustrine indet.
80783	Haptodus	United Kingdc	52.375	-1.575	1	5.42	5.42	12.8	Cisuralian	Asselian	Permian 1	Asselian		294.5	Kenilworth Sandstone		fluvial indet.
89649	Ophiacodon	United Kingdc	52.413889	-1.519444	1	5.46	5.46	12.82	Cisuralian	Asselian	Permian 1	Asselian		294.5	Kenilworth Sandstone		fluvial indet.
13257	Eryops	United States	37.174167	-109.84806	1	5.85	5.85	-36.01	Cisuralian		Permian 1	Asselian	Sakmarian	291.5	Cutler		"channel"
85474	Haptodus	Germany	51.018611	13.638056	1	6.31	6.31	22.31	Cisuralian	Asselian	Permian 1	Asselian		294.5	D˜hlen	1. Flˆz (1st s	fine channel fill
51265	Discosauriscus	Czech Republ	49.493056	16.656111	1	6.52	6.52	25.3	Cisuralian		Permian 1	Asselian	Sakmarian	291.5			terrestrial indet.
85481	Diadectes	United States	37.996389	-108.02028	1	6.54	6.54	-33.87	Cisuralian			Wolfcamp		289.25	Cutler		fluvial-lacustrine indet.
85479	Platyhystrix	United States	38.005556	-108.03583	1	6.55	6.55	-33.88	Cisuralian			Wolfcamp		289.25	Cutler		fluvial-lacustrine indet.
85480	Cutleria	United States	37.999444	-108.02917	1	6.55	6.55	-33.88	Cisuralian			Wolfcamp		289.25	Cutler		fluvial-lacustrine indet.
85478	Mycterosaurus	United States	38.006111	-108.04222	1	6.56	6.56	-33.88	Cisuralian			Wolfcamp		289.25	Cutler		fluvial-lacustrine indet.
85475	Cutleria	United States	38.02	-108.04639	1	6.57	6.57	-33.87	Cisuralian			Wolfcamp		289.25	Cutler		fluvial-lacustrine indet.
85476	Ophiacodon	United States	38.036389	-108.12361	1	6.62	6.62	-33.91	Cisuralian			Wolfcamp		289.25	Cutler		fluvial-lacustrine indet.
80110	Tseajaia	United States	37.035	-110.06306	1	7.68	7.68	-35.3	Cisuralian			Wolfcamp	Leonard	285.75	Cutler	Organ Rock S	"floodplain"
52522	Onchiodon	Germany	50.999722	13.650278	1	8.98	8.98	23.93	Cisuralian	Sakmarian	Permian 1	Sakmarian		287	Niederh ‰ sli	Niederh ‰ sli	lacustrine indet.
121601	Tambaroter	Germany	50.783333	10.616667	1	9.89	9.89	23.12	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Tambach	Finsterberger	fluvial-lacustrine indet.
80112	Orobates	Germany	50.809722	10.618889	1	9.91	9.91	23.11	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Tambach	Tambach-Sar	fluvial-lacustrine indet.
28463	Branchiosaurus	Italy	40.2	9.2	1	2.56	2.56	21.54				Autunian	Permian	275.65			pond
28464	Branchiosaurus	Italy	40.2	9.2	1	2.56	2.56	21.54				Autunian	Permian	275.65			pond
28465	Branchiosaurus	Italy	40.2	9.2	1	2.56	2.56	21.54				Autunian	Permian	275.65			pond
58139	Branchiosaurus	Czech Republ	50.583889	16.335833	1	12.05	12.05	27.2				Rotliegendes		277			terrestrial indet.
27263	Archegosaurus	India	34.041667	74.908333	1	50.35	-50.35	59.42				Rotliegendes		277			terrestrial indet.
27487	Rothianiscus	United States	35.674444	-97.985833	2	4.13	4.13	-26.7	Guadalupian		Permian 3	Roadian	Wordian	268.75	Flowerpot		deltaic indet.
27485	Rothianiscus	United States	35.816389	-98.131111	2	4.31	4.31	-26.74	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
27574	Cymatorhiza	United States	35.911111	-98.154444	2	4.41	4.41	-26.72	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
27482	Rothianiscus	United States	35.904167	-98.206944	2	4.42	4.42	-26.76	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
27573	Rothianiscus	United States	35.941667	-98.209722	2	4.45	4.45	-26.74	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		"channel"
27400	Rothianiscus	United States	35.971111	-98.316667	2	4.52	4.52	-26.81	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
27407	Cotylorhynchus	United States	35.986111	-98.315833	2	4.53	4.53	-26.8	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
27414	Cotylorhynchus	United States	35.995556	-98.358889	2	4.56	4.56	-26.82	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		"floodplain"
27475	Watongia	United States	35.999444	-98.375833	2	4.57	4.57	-26.84	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
27480	Rothianiscus	United States	36.010556	-98.361389	2	4.57	4.57	-26.82	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
27479	Macroleter	United States	36.019722	-98.368333	2	4.58	4.58	-26.82	Guadalupian		Permian 3	Roadian	Wordian	268.75	Chickasha		deltaic indet.
80057	Tokosaurus	Russian Feder	52.583333	54.416667	2	27.3	27.3	47.77	Guadalupian	Roadian	Permian 3	Kazanian		270.25	Belebei		carbonate indet.
80875	Ulemosaurus	Russian Feder	52.555	54.146944	2	27.86	27.86	47.79	Guadalupian	Wordian	Permian 3	Urzhumian		266.5	Bolshekinelskaya		coastal indet.
85487	Konzhukovia	Russian Feder	52.435556	54.468056	2	27.9	27.9	48.04	Guadalupian	Wordian	Permian 3	Urzhumian		266.5	Bolshekinelskaya		deltaic indet.
87039	Platyoposaurus	Russian Feder	52.259167	54.845556	2	27.92	27.92	48.37	Guadalupian	Wordian	Permian 3	Urzhumian		266.5			deltaic indet.
36273	Enosuchus	Russian Feder	53.374722	52.807778	2	27.94	27.94	46.49	Guadalupian	Wordian	Permian 3	Urzhumian		266.5	Amanakskaya		terrestrial indet.
79969	Belebey	Russian Feder	53.650556	53.565278	2	27.98	27.98	46.58	Guadalupian		Permian 3	Kazanian	Urzhumian	268.75	Belebei		lacustrine delta plain
80688	Phreatophasma	Russian Feder	53.666667	54.333333	2	28.07	28.07	46.91	Guadalupian	Roadian	Permian 3	Kazanian		270.25			marginal marine indet.
27341	Belebey	Russian Feder	54.108333	54.125	2	28.31	28.31	46.47	Guadalupian	Roadian	Permian 3	Kazanian		270.25	Belebei		fluvial indet.
84717	Gecatogomphius	Russian Feder	55.716667	51.4	2	28.47	28.47	43.92	Guadalupian	Roadian	Permian 3	Kazanian		270.25	Belebei		fluvial indet.
79166	Gecatogomphius	Russian Feder	56.691667	50.633333	2	28.92	28.92	42.82	Guadalupian	Roadian	Permian 3	Kazanian		270.25	Belebei		fluvial indet.
85962	Ulemosaurus	Russian Feder	53.433333	55.25	2	28.95	28.95	47.68	Guadalupian	Wordian	Permian 3	Urzhumian		266.5			terrestrial indet.
37065	Melosaurus	Russian Feder	53.666667	55.75	2	29.33	29.33	47.75	Guadalupian	Wordian	Permian 3	Wordian		266.5			terrestrial indet.
87102	Eotitanosuchus	Russian Feder	57.813333	54.706667	2	31.93	31.93	43.93	Guadalupian	Wordian	Permian 3	Urzhumian		266.5			delta plain
85431	Anakamacops	China	39.704167	97.7375	2	32.94	32.94	78.49	Guadalupian	Roadian	Permian 3	Roadian		270.25	Xidagou		fluvial indet.
79948	Bashkyroleter	Russian Feder	65.591667	44.554722	2	33.95	33.95	33.42	Guadalupian		Permian 3	Kazanian	Urzhumian	268.75	Krasnoshchel'		terrestrial indet.
78657	Provelosaurus	Brazil	-30.016667	-54.15	2	46.28	-46.28	-28.77	Guadalupian		Permian 3	Wordian	Capitanian	264.25	Rio do Rasto	Morro Pelado	terrestrial indet.
106558	Tiarajudens	Brazil	-30.25	-54.383333	2	46.64	-46.64	-30.06	Guadalupian		Permian 3	Guadalupian		266.5	Rio do Rasto		terrestrial indet.
89626	Australothyris	South Africa	-32.108333	21.225	2	58.88	-58.88	-34.36	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
94617	Glanosuchus	South Africa	-32.647222	21.516667	2	59.28	-59.28	-35.2	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	? Abrahamskraal		"floodplain"
26710	Bradysaurus	South Africa	-32.328611	21.795278	2	59.41	-59.41	-34.47	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
93097	Bradysaurus	South Africa	-32.695833	21.75	2	59.48	-59.48	-35.18	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
88394	Eunotosaurus	South Africa	-31.135	22.378333	2	59.49	-59.49	-31.93	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
93084	Bradysaurus	South Africa	-32.4625	21.864444	2	59.5	-59.5	-34.68	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
90244	Eunotosaurus	South Africa	-32.920833	21.736111	2	59.54	-59.54	-35.61	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		dry floodplain
94778	Eodicynodon	South Africa	-33.025	21.683333	2	59.56	-59.56	-37.89	Guadalupian	Wordian	Permian 3	Wordian		266.5	Abrahamskraal		terrestrial indet.
13004	Bradysaurus	South Africa	-32.366667	22	2	59.58	-59.58	-34.43	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
93096	Bradysaurus	South Africa	-32.491667	22.166667	2	59.76	-59.76	-34.58	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"

93100	Bradysaurus	South Africa	-32.427778	22.191667	2	59.76	-59.76	-34.45	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
86388	Bradysaurus	South Africa	-32.905556	22.033333	2	59.77	-59.77	-35.43	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		"floodplain"
75451	Patranomodon	South Africa	-33.1667	21.98333	2	59.84	-59.84	-38.04	Guadalupian	Wordian	Permian 3	Wordian		266.5			terrestrial indet.
75452	Eodicynodon	South Africa	-33.8333	21.83333	2	59.88	-59.88	-39.39	Guadalupian		Permian 3	Guadalupian		266.5	Abrahamskraal		terrestrial indet.
85515	Galechirus	South Africa	-31.4	23.116667	2	60.17	-60.17	-32	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Abrahamskraal		terrestrial indet.
94649	Eodicynodon	South Africa	-33.1125	22.538889	2	60.28	-60.28	-37.7	Guadalupian	Wordian	Permian 3	Wordian		266.5	Abrahamskraal		delta plain
94777	Eodicynodon	South Africa	-33.175	22.541667	2	60.3	-60.3	-37.82	Guadalupian	Wordian	Permian 3	Wordian		266.5	Abrahamskraal		delta plain
94779	Eodicynodon	South Africa	-33.0625	22.945833	2	60.6	-60.6	-37.43	Guadalupian	Wordian	Permian 3	Wordian		266.5	Abrahamskraal		delta plain
94607	Lanthanostegus	South Africa	-32.958333	24.403333	2	61.69	-61.69	-34.34	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Koonap		delta plain
75450	Pachydectes	South Africa	-32.970556	24.560833	2	61.84	-61.84	-34.85	Guadalupian		Permian 3	Wordian	Capitanian	264.25	Koonap		fluvial indet.
89845	Broomia	South Africa	-33.063333	26.394444	2	63.32	-63.32	-33.52	Guadalupian	Capitanian	Permian 3	Capitanian		262.75	Koonap		delta plain
79588	Acrodenta	Morocco	30.836389	-9.079167	3	2.06	2.06	3.66	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Ikakern	Tourbihine	terrestrial indet.
89607	Arganaceras	Morocco	30.825833	-9.089167	3	2.06	2.06	3.65	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Ikakern	Tourbihine	terrestrial indet.
85564	Parasaurus	Germany	50.683333	10.916667	3	15.29	15.29	22.92	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
81115	Parasaurus	Germany	50.991389	9.931111	3	15.39	15.39	22.21	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
85488	Coelurosauravus	Germany	50.992778	9.943056	3	15.39	15.39	22.21	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
85489	Parasaurus	Germany	50.996667	9.953333	3	15.4	15.4	22.22	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
85557	Coelurosauravus	Germany	51.0075	9.915833	3	15.4	15.4	22.19	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
84836	Procynosuchus	Germany	51.261944	8.880278	3	15.45	15.45	21.47	Lopingian		Permian 4	Zechstein		256.4	Werra		fissure fill
85561	Parasaurus	Germany	51.583333	10.616667	3	16.08	16.08	22.44	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
85490	Coelurosauravus	Germany	51.585278	10.665278	3	16.09	16.09	22.47	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
85565	Parasaurus	Germany	51.541667	10.865	3	16.09	16.09	22.61	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
85484	Coelurosauravus	Germany	51.516667	11.516667	3	16.2	16.2	23.01	Lopingian		Permian 4	Zechstein		256.4	Werra	Kupferschiefe	offshore
68054	Moradisaurus	Niger	18.783333	7.197222	3	16.54	-16.54	8.24	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Moradi		"floodplain"
68053	Nigerpeton	Niger	18.791944	7.219444	3	16.55	-16.55	8.26	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Moradi		"floodplain"
84824	Moradisaurus	Niger	18.510556	7.533333	3	16.94	-16.94	8.38	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Moradi		"floodplain"
87004	Adelosaurus	United Kingdc	54.622222	-1.621111	3	17.17	17.17	14.23	Lopingian		Permian 4	Zechstein		256.4	Marl Slate		lagoonal/restricted shallow
77197	Coelurosauravus	United Kingdc	54.816667	-1.45	3	17.38	17.38	14.3	Lopingian		Permian 4	Zechstein		256.4		Marl Slate	lagoonal/restricted shallow
86346	Megawhaitsia	Russian Feder	56.253056	42.092778	3	28.81	28.81	37.66	Lopingian		Permian 4	Vyatkian		256.4			"floodplain"
78694	Shihtienfenia	China	37.433333	110.883333	3	29.83	29.83	89.58	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Shihtienfeng (Shiqianfeng)		fluvial indet.
93536	Shihtienfenia	China	39.016667	111.075	3	31.23	31.23	90.46	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Shihtienfeng (Shiqianfeng)		terrestrial indet.
92907	Shansisaurus	China	37.433333	110.883333	3	31.5	31.5	89.22	Lopingian		Permian 4	Lopingian		256.4	Shihtienfeng (Shiqianfeng)		terrestrial indet.
92909	Shansisaurus	China	37.433333	110.883333	3	31.5	31.5	89.22	Lopingian		Permian 4	Lopingian		256.4	Shiqianfeng (Shihtienfeng)		terrestrial indet.
86356	Archosaurus	Russian Feder	57.733333	47.016667	3	31.67	31.67	38.95	Lopingian		Permian 4	Vyatkian		256.4			terrestrial indet.
93016	Obirkovia	Russian Feder	59.964444	43.108333	3	32.04	32.04	35.43	Lopingian		Permian 4	Vyatkian		256.4	Salarevo		terrestrial indet.
27952	Elph	Russian Feder	61.191111	46.635	3	34.1	34.1	36.01	Lopingian		Permian 4	Vyatkian		256.4	Salarevo		terrestrial indet.
28065	Scutosaurus	Russian Feder	61.191111	46.635	3	34.1	34.1	36.01	Lopingian		Permian 4	Vyatkian		256.4	Salarevo		terrestrial indet.
85512	Coelurosauravus	Madagascar	-22.558333	45.4125	3	52.35	-52.35	27.78	Lopingian		Permian 4	Lopingian		256.4	Lower Sakamena		paralic indet.
85505	Claudiosaurus	Madagascar	-22.666667	45.35	3	52.4	-52.4	27.6	Lopingian		Permian 4	Lopingian		256.4	Lower Sakamena		paralic indet.
85506	Claudiosaurus	Madagascar	-23.45	45.083333	3	52.89	-52.89	26.51	Lopingian		Permian 4	Lopingian		256.4	Lower Sakamena		paralic indet.
85494	Acerosodontosau	Madagascar	-24	44.416667	3	52.96	-52.96	25.16	Lopingian		Permian 4	Lopingian		256.4	Lower Sakamena		terrestrial indet.
84914	Captorhinus	Zambia	-10.833333	33.166667	3	54.86	-54.86	12.46	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Madumabisa Mudstone		terrestrial indet.
86257	Pareiasuchus	Zambia	-10.833333	33.166667	3	54.86	-54.86	12.46	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Madumabisa Mudstone		terrestrial indet.
38064	Dicynodon	Tanzania	-10.183333	35.083333	3	54.97	-54.97	15.96	Lopingian		Permian 4	Zechstein		256.4	Lower Bone Bed		terrestrial indet.
38065	Dicynodon	Tanzania	-10.183333	35.083333	3	54.97	-54.97	15.96	Lopingian		Permian 4	Zechstein		256.4	Lower Bone Bed		terrestrial indet.
88618	Lystrosaurus	Zambia	-12.333333	32	3	55.42	-55.42	12.01	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Madumabisa Mudstone		lacustrine - large
80572	Endothiodon	India	19.25	79.25	3	55.73	-55.73	42.97	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Kundaram		wet floodplain
115685	Galesphyrus	South Africa	-31.5	19.45	3	58.05	-58.05	-31.65	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75			terrestrial indet.
84714	Youngina	South Africa	-31.925	22.4	3	60.53	-60.53	-30.75	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Teekloof	Hoedemaker	dry floodplain
31777	Pristerognathus	South Africa	-32	22	3	61.07	-61.07	-29.96	Lopingian		Permian 4	Zechstein		256.4	Karoo		fluvial indet.
88342	Youngoides	South Africa	-32.104167	23.863333	3	61.75	-61.75	-30.12	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Teekloof		"floodplain"
114631	Emydops	South Africa	-32.133333	24.216667	3	62.04	-62.04	-29.94	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Balfour	Oudeberg	"floodplain"
92654	Owenetta	South Africa	-31.866667	24.55	3	62.2	-62.2	-29.18	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Middleton or Balfour		terrestrial indet.
80826	Pareiasuchus	South Africa	-32.25	24.533333	3	62.33	-62.33	-29.96	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75	Middleton or Balfour		terrestrial indet.
115686	Galesphyrus	South Africa	-30.68	25.33	3	62.34	-62.34	-26.27	Lopingian	Wuchiapingia	Permian 4	Wuchiapingian		257.75			terrestrial indet.
80176	Milleropsis	South Africa	-31.95	23.766667	3	63.16	-63.16	-27.12	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
80178	Milleretta	South Africa	-31.95	23.766667	3	63.16	-63.16	-27.12	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
80223	Milleretta	South Africa	-31.908056	23.888889	3	63.23	-63.23	-26.94	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Teekloof		terrestrial indet.
89859	Milleretta	South Africa	-32.152778	23.894444	3	63.35	-63.35	-27.42	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
86258	Burnetia	South Africa	-31.761389	24.169167	3	63.38	-63.38	-26.41	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
89863	Millerosaurus	South Africa	-32.060833	24.192778	3	63.53	-63.53	-26.99	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
80174	Nanomilleretta	South Africa	-32.043333	24.215556	3	63.54	-63.54	-26.93	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
80216	Milleretta	South Africa	-32.053333	24.288889	3	63.6	-63.6	-26.89	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.

80220	Milleretta	South Africa	-31.859444	24.440833	3	63.63	-63.63	-26.37	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
80219	Milleropsis	South Africa	-31.866667	24.55	3	63.72	-63.72	-26.29	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
80225	Milleretta	South Africa	-31.866667	24.55	3	63.72	-63.72	-26.29	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
80226	Millerinoides	South Africa	-31.958333	24.573611	3	63.78	-63.78	-26.46	Lopingian	Changhsingia	Permian 4	Changhsingian		253.65	Balfour		terrestrial indet.
89833	Brazilosaurus	Brazil	-17.25	-52.716667		36.51	-36.51	-26.75	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Irati	Assistencia	carbonate indet.
84719	Intasuchus	Russian Feder	66.033333	60.05		36.74	36.74	38.23	Cisuralian		Permian 2	Artinskian	Ufimian	278.25	Inta		terrestrial indet.
89839	Brazilosaurus	Brazil	-17.483333	-52.053333		36.96	-36.96	-26.12	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Irati	Assistencia	carbonate indet.
90832	Stereosternum	Paraguay	-25.783333	-56.45		42.79	-42.79	-35.05	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	? San Miguel		marine indet.
90214	Brazilosaurus	Brazil	-23.35	-47.85		43.87	-43.87	-24.13	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Irati	Assistencia	carbonate indet.
90863	Mesosaurus	Uruguay	-31.933333	-54.016667		49.27	-49.27	-35.94	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Melo	Mangrullo	marine indet.
90865	Mesosaurus	Uruguay	-31.933333	-54.016667		49.27	-49.27	-35.94	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Melo	Mangrullo	marine indet.
28468	Mesosaurus	Namibia	-21.2	14.05		50.15	-50.15	-29.11	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Huab		lacustrine indet.
28469	Mesosaurus	Namibia	-21.2	14.05		50.15	-50.15	-29.11	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Huab		lacustrine indet.
28470	Mesosaurus	Namibia	-21.2	14.05		50.15	-50.15	-29.11	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Huab		lacustrine indet.
28471	Mesosaurus	Namibia	-21.2	14.05		50.15	-50.15	-29.11	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Huab		lacustrine indet.
90780	Mesosaurus	Namibia	-25.836111	18.010278		55.19	-55.19	-34.15	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	? Whitehill		marine indet.
90755	Mesosaurus	Namibia	-26.319444	18.246944		55.54	-55.54	-34.85	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Whitehill		marine indet.
89799	Mesosaurus	South Africa	-29.646389	24.203056		61.45	-61.45	-38.55	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	? Whitehill		offshore
90257	Mesosaurus	South Africa	-28.7375	24.766667		61.75	-61.75	-36.47	Cisuralian	Artinskian	Permian 2	Artinskian		281.75	Whitehill		offshore
127181	Pareiasaurus	United States	38.768611	-80.615833		0.68	0.68	-13.02				Permian		275.65			terrestrial indet.
127038	Megamolgophis	United States	39.065	-81.376111		1.15	1.15	-13.48				Permian		275.65	Greene		terrestrial indet.
126544	Diploceraspis	United States	39.046944	-81.4925		1.17	1.17	-13.57				Permian		275.65	Greene	middle	terrestrial indet.
126584	Diploceraspis	United States	39.048056	-81.538889		1.18	1.18	-13.6				Permian		275.65	Greene	upper	terrestrial indet.
126583	Diploceraspis	United States	39.244444	-81.413889		1.33	1.33	-13.45				Permian		275.65	Greene	mdidle	terrestrial indet.
126582	Diploceraspis	United States	39.241667	-81.461111		1.34	1.34	-13.48				Permian		275.65	Greene	middle	terrestrial indet.
126546	Diploceraspis	United States	39.750556	-79.840833		1.42	1.42	-12.13				Permian		275.65	Greene	middle	terrestrial indet.
126548	Diploceraspis	United States	39.677222	-80.314444		1.47	1.47	-12.5				Permian		275.65	Greene	upper	terrestrial indet.
126575	Diploceraspis	United States	39.66	-80.4		1.47	1.47	-12.57				Permian		275.65	Greene	upper	terrestrial indet.
126577	Diploceraspis	United States	39.633333	-80.573056		1.49	1.49	-12.71				Permian		275.65	Greene	upper	terrestrial indet.
126578	Diploceraspis	United States	39.646389	-80.531111		1.49	1.49	-12.67				Permian		275.65	Greene	middle	terrestrial indet.
126580	Diploceraspis	United States	39.623056	-80.649167		1.5	1.5	-12.76				Permian		275.65	Greene	upper	terrestrial indet.
126581	Diploceraspis	United States	39.625	-80.701944		1.51	1.51	-12.8				Permian		275.65	Greene	middle	terrestrial indet.
126542	Diploceraspis	United States	39.710278	-80.823889		1.62	1.62	-12.86				Permian		275.65	Greene	lower	terrestrial indet.
126543	Diploceraspis	United States	39.783056	-80.549444		1.63	1.63	-12.64				Permian		275.65	Greene	lower	terrestrial indet.
126547	Diploceraspis	United States	39.776944	-80.601944		1.63	1.63	-12.68				Permian		275.65	Greene	upper	marine indet.
126574	Diploceraspis	United States	39.864444	-80.389722		1.66	1.66	-12.5				Permian		275.65	Greene	lower	terrestrial indet.
126579	Diploceraspis	United States	39.773611	-80.844444		1.69	1.69	-12.86				Permian		275.65	Greene	middle	terrestrial indet.
126549	Diploceraspis	United States	39.796111	-80.8125		1.7	1.7	-12.83				Permian		275.65	Greene	upper	terrestrial indet.
126570	Diploceraspis	United States	39.870833	-80.6825		1.74	1.74	-12.71				Permian		275.65	Greene	middle	terrestrial indet.
126545	Diploceraspis	United States	39.904167	-80.774444		1.8	1.8	-12.77				Permian		275.65	Greeene	middle	terrestrial indet.
126571	Diploceraspis	United States	39.992778	-80.543611		1.82	1.82	-12.57				Permian		275.65	Greene	middle	terrestrial indet.
126572	Diploceraspis	United States	40.006111	-80.693056		1.87	1.87	-12.67				Permian		275.65	Greene	middle	terrestrial indet.
125142	Zatrachys	United States	40.045556	-80.651389		1.9	1.9	-12.63				Permian		275.65	Washington	Wolfcampian	terrestrial indet.
80729	Rothianiscus	United States	33.519722	-99.961111		2.53	2.53	-29.32				Kungurian	Roadian	273.75	San Angelo		terrestrial indet.
80717	Slaugenhopia	United States	33.524444	-99.975		2.54	2.54	-29.33				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	terrestrial indet.
80692	Caseoides	United States	33.530278	-99.9875		2.55	2.55	-29.34				Kungurian	Roadian	273.75	San Angelo		terrestrial indet.
80668	Cotylorhynchus	United States	33.621944	-99.926944		2.6	2.6	-29.25				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	terrestrial indet.
80014	Kahneria	United States	33.621944	-99.934444		2.61	2.61	-29.25				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	fluvial indet.
80917	Cotylorhynchus	United States	33.6275	-99.930556		2.61	2.61	-29.25				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	fluvial indet.
85170	Mastersonia	United States	33.639167	-99.9275		2.62	2.62	-29.24				Kungurian	Roadian	273.75	San Angelo		fluvial-deltaic indet.
85171	Rothianiscus	United States	33.645556	-99.925833		2.63	2.63	-29.24				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	fluvial indet.
85281	Cotylorhynchus	United States	33.642778	-99.948056		2.63	2.63	-29.25				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	"floodplain"
79600	Cotylorhynchus	United States	33.66	-99.938333		2.64	2.64	-29.24				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	fluvial indet.
85280	Cotylorhynchus	United States	33.652778	-99.95		2.64	2.64	-29.25				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	"floodplain"
78559	Kahneria	United States	33.718056	-99.907778		2.68	2.68	-29.19				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	fluvial-deltaic indet.
80669	Cotylorhynchus	United States	33.7125	-99.917778		2.68	2.68	-29.2				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	terrestrial indet.
80689	Dimetrodon	United States	33.690833	-99.953611		2.68	2.68	-29.23				Kungurian	Roadian	273.75	San Angelo		"floodplain"
79694	Rothianiscus	United States	34.1	-99.733333		2.94	2.94	-28.87				Kungurian	Roadian	273.75	San Angelo	Flowerpot Sh	fluvial indet.
93207	Microphon	Russian Feder	51.470833	55.141667		29.04	29.04	49.45				Severodvinian		260	Malokinelskaya		fluvial-lacustrine indet.
27931	Titanophoneus	Russian Feder	55.148611	48.531389		29.28	29.28	43.28				Late/Upper U	Early/Lower S	260.15			fluvial indet.
22730	Platyoposaurus	Russian Feder	54.6666	50		29.45	29.45	44.38				Late/Upper U	Early/Lower S	260.15			terrestrial indet.
28855	Scutosaurus	Russian Feder	55.017222	48.828611		29.54	29.54	43.14				Late/Upper S	Early/Lower V	258.65			terrestrial indet.
80712	Scutosaurus	Russian Feder	55.017222	48.828611		29.54	29.54	43.14				Late/Upper S	Early/Lower V	258.65			terrestrial indet.

86484	Kinelia	Russian Feder	53.295	53.015	29.55	29.55	46.95	Urzhumian	Vyatkian	260.15	Kutulukskaya		fluvial-deltaic indet.
37202	Dvinosaurus	Russian Feder	61.2611	46.6556	29.65	29.65	37.44	Permian		275.65			terrestrial indet.
85483	Rautiania	Russian Feder	51.875833	56.290833	30.12	30.12	49.37	Severodvinia	Vyatkian	258.65	Vyasovka		lacustrine deltaic indet.
87040	Platyoposaurus	Russian Feder	56.333333	50.75	30.53	30.53	43.43	Kazanian	Tatarian	262.4			terrestrial indet.
28854	Emeroleter	Russian Feder	58.15	48.351667	31.52	31.52	40.97	Severodvinian		260	Urpalov		terrestrial indet.
119783	Australobarbarus	Russian Feder	58.2788183	48.319931	31.84	31.84	40.43	Early/Lower Severodvinian		258.65	Urpalov		terrestrial indet.
80022	Nycteroleter	Russian Feder	58.635833	49.845	31.94	31.94	41.23	Late/Upper K	Early/Lower S	262.4			deltaic indet.
120215	Delectosaurus	Russian Feder	59.361195	50.339355	33.34	33.34	40.5	Late/Upper Vyatkian		258.65			terrestrial indet.
80685	Ennatosaurus	Russian Feder	64.133333	41.9	34.16	34.16	33.59	Severodvinian		260			terrestrial indet.
85160	Ennatosaurus	Russian Feder	64.916667	45.758333	35.83	35.83	34.52	Late/Upper U	Early/Lower S	260.15	Krasnoshchel'		terrestrial indet.
95349	Chirotherium	Spain	39.69438	2.525514	39.69	39.69	2.53	Buntsandstein		258.65			"floodplain"
22661	Diictodon	South Africa	-31.9166	21.5166	58.97	-58.97	-32.34	Capitanian	Wuchiapingia	260	Teekloof		crevasse splay
22662	Diictodon	South Africa	-31.9166	21.5166	58.97	-58.97	-32.34	Capitanian	Wuchiapingia	260	Teekloof		fluvial indet.
86301	Diictodon	South Africa	-32.229444	21.566389	59.12	-59.12	-32.88	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86302	Diictodon	South Africa	-32.233056	21.566389	59.12	-59.12	-32.89	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86297	Oudenodon	South Africa	-32.206667	21.605556	59.14	-59.14	-32.82	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86286	Pristerodon	South Africa	-32.188056	21.623611	59.15	-59.15	-32.77	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86296	Diictodon	South Africa	-32.189722	21.622222	59.15	-59.15	-32.78	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86298	Diictodon	South Africa	-32.211111	21.6125	59.15	-59.15	-32.82	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86300	Diictodon	South Africa	-32.221667	21.601389	59.15	-59.15	-32.85	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86276	Diictodon	South Africa	-32.225278	21.613889	59.16	-59.16	-32.85	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86284	Oudenodon	South Africa	-32.212222	21.626944	59.16	-59.16	-32.82	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86285	Diictodon	South Africa	-32.205833	21.629722	59.16	-59.16	-32.8	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86299	Diictodon	South Africa	-32.221667	21.6125	59.16	-59.16	-32.84	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86303	Charassognathus	South Africa	-32.198611	21.624444	59.16	-59.16	-32.79	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86282	Diictodon	South Africa	-32.217778	21.641389	59.18	-59.18	-32.82	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86278	Diictodon	South Africa	-32.259444	21.656389	59.2	-59.2	-32.89	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86279	Diictodon	South Africa	-32.251389	21.655	59.2	-59.2	-32.87	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86280	Diictodon	South Africa	-32.239167	21.659444	59.2	-59.2	-32.85	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	crevasse splay
86275	Lobalopex	South Africa	-31.651944	22.511111	59.67	-59.67	-31.58	Capitanian	Wuchiapingia	260	Teekloof	Hoedemaker	terrestrial indet.
116452	Pristerodon	South Africa	-31.9167	23.6667	60.96	-60.96	-39.76	Permian		275.65			terrestrial indet.
114905	Pelanomodon	South Africa	-31.9167	24.7167	61.83	-61.83	-39.41	Permian		275.65			terrestrial indet.