MORPHOLOGY OF THE PEBBLES OF THE CAMPANIAN LOKOJA FORMATION, SOUTHERN BIDA BASIN, NIGERIA: IMPLICATIONS FOR PALAEO-DEPOSITIONAL ENVIRONMENTS AND PROCESSES

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Abstract: Pebble components of the Arkosic Sandstone deposits of the Lokoja Formation were subjected to macro- and micromorphological investigation in order to infer the depositional environments and the energy regimes under which the formation was formed. The long (L), intermediate (I) and short (S) axes of 338 carefully selected pebbles from the Lokoja Formation were measured using digital Vernier Calliper. Form indices, including Coefficient of Flatness (C.F), Oblate-Prolate (OP), Maximum Projection Sphericity Index (M.P.S.I.) and Elongation Ratio (E.R) were calculated from the measured parameters. Roundness of the pebbles were also individually measured. The calculated mean values: C.F. (62.5%), OP (0.179), M.P.S.I. (1.515), E.R. (0.788) and Roundness (0.331) from the form indices are above the lower limits for fluvial shaped pebbles. Scatter plots of M.P.S.I. against OP, Roundness vs E.R and C.F against M.P.S.I. correlate well with typical plots of fluvial shaped pebbles, therefore indicating the deposition of the pebbles of Lokoja Formation in a fluvial setting. The scanning Electron Microscopy (SEM) result suggests deposition in high-energy environment.
Keywords: Maastrichtian, morphometric, Lokoja formation, pebble, paleoinvironment

Introduction

The Arkosic Sandstone deposits of the Lokoja Formation constitute the oldest sedimentary sequence in the southern sector of the Bida Basin (Fig. 1). The formation directly overlies the Pre-Cambrian Basement Complex of Nigeria non-conformably. The basal unit, as observed in many outcrop sections, especially at the outskirt of Lokoja Town is abundant in pebbles embedded in matrix of silty, fine to coarse grained sandstone. In places, the pebbles form the bedding planes separating beds from one another (Figs. 2, 3).

The Bida Basin, severally referred to as Nupe or Mid-Niger Basin by earlier workers (Adeleye, 1973; Jan Du Chene *et al*., 1978; Kogbe *et al*., 1983; Adeleye, 1988), comprises the northern and southern sectors called the Northern and Southern Bida Basins respectively. The basin which is contiguous with the Anambra Basin trends northeast – southwest (Fig. 1). It started receiving sediments in the Upper Cretaceous, coinciding with the third major transgressive cycle of the southern Nigeria. However, prior to this event, continentally derived sediments of the Lokoja Formation have accumulated in the basin. Thickness of sedimentary successions at the center of the basin have been reported to be in the order of 3.5 Km (Ojo, 1984).

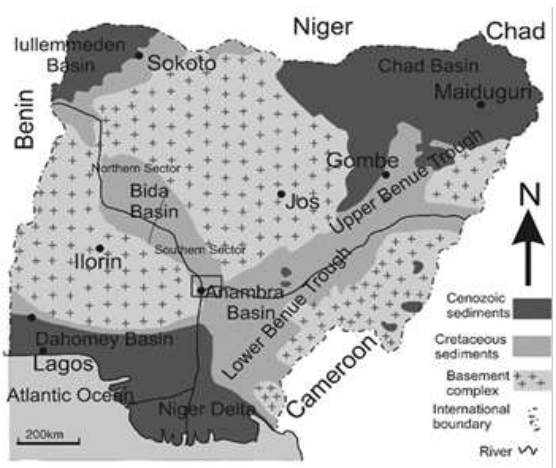

Fig. 1: Geological map of Nigeria showing the major sedimentary basins and the basement complex. Box: indicates the study area

Earlier research on the geology and evolution of the Bida Basin dates back to the pioneer works of Russ, 1957; Adeleye, 1973, 1974; Ojo and Ajakaiye, 1989. Information on the stratigraphy and depositional environments of the sedimentary sequences in the basin have been provided and variously extensively discussed in the works of Adeleye (1975); Jan Du Chene *et al*. (1978); Osokpor *et al*. (2013); Nton and Adamolekun (2016); Okosun *et al*. (2007); Ojo and Akande (2009); Ojo *et al*. (2011). The origin and abundance of ironstone in the basin have been the subjects of discussion in many published works including Ladipo *et al*. (1994); Abimbola (1997). Petroleum generative potentials of the shale sequence in the basin have been reported in Braide (1992); Akande *et al*. (2005); Obaje *et al.* (2011).

The present study is focused on the depositional environmental implications of the morphology of the pebble component and also the energy regime which prevailed during the deposition of the Lokoja Formation. The study is not only based on shape of the pebbles and the conglomerates, we have also conducted analysis on the surface texture using SEM. Pebble morphometric studies have been carried by several authors (Dobkins and Folk, 1970; Lutig, 1962; Krumbein, 1941; Olugbenro and Nwajide, 1997; Widera, 2010) to provide information on the depositional environments, history of deposition and the hydrodynamic behaviour of particles in a transporting medium. Detrital rock particles from weathering (source) through deposition site is subjected to individual process of shape forming, the shape of such rock particle is dependent on the type of medium responsible for the transportation during erosion (Luttig 1962).Therefore, shape and the surface texture of pebbles are pointers to deposition processes and medium of transportation.

Stratigraphic setting

The northwest-southeast trending Bida Basin comprises of two sectors namely Northern and Southern Bida Sub-basins. The oldest sedimentary unit, non-conformably overlying the Pre-Cambrian to Lower Paleozoic basement complex in the southern Bida Sub-basin is the Campanian Lokoja Formation (Akande *et al*., 2005) with its lateral equivalence in the northern sector being the Bida Formation (Obaje *et al*., 2011). Conformably overlying the Lokoja Formation is the partly continental and partly marine sedimentary sequence of the Patti Formation with its lateral equivalent in northern sector as the Sakpe Ironstone and lower succession of the Enagi Sandstone. The Patti and Enagi Formations are succeeded by the Upper Maastrichtian (Obaje *et al*., 2011) Agbaja and Batati Formations of the southern and northern Bida Sub-basins, respectively. The present study is focused on the southern sector of the basin; therefore, emphasis on the stratigraphy is on this sector.

Regional litho-stratigraphic setting

Lokoja formation

This lithological unit outcrops directly on top of the basement rocks of schist and gneises at Crusher (approximately 1 km to Filele junction) in the outskirt of Lokoja (Figs. 2 and 3) where the samples for the present study were recovered. The unit consists of conglomerates, course to fine grained sandstones, siltstones and clay all mixed in a typical debris flow setting. The pebbles and cobbles are subangular to subrounded with some being well rounded. These particles are irregularly embedded in clay-siltstone matrix. Observations show that the matrix and grain supported conglomerates form bedding planes (Figs. 2 and 3) at the lower part of the section, denoting cycles of fining upward sequences. The sediments of the Lokoja Formation as observed on outcrop sections is characterised by poorly sorted, feldspar rich sandstones indicating textural and mineralogical immaturity.

Fig. 2: An exposed section of the Lokoja formation at crusher along the Lokoja-Abuja highway in Lokoja

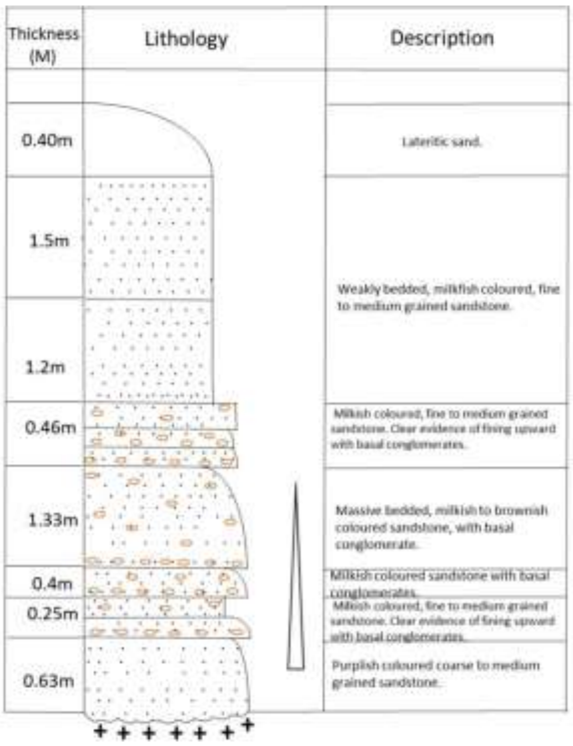

Fig. 3: Lithological section of the Lokoja Formation exposed at Crusher area, Lokoja

Patti formation

Directly overlying the Lokoja Formation is the sandstone, siltstone, claystone units of the Patti Formation outcropping between Kotonkarfi and Abaji along the Lokoja-Abuja Highway. The shale member of this formation outcrops at an abandoned mine in Ahoko Village some kilometres after the Niger Bridge. Also, the formation outcrops in a road-cut outcrop along the Lokoja-Agbaja Road just about 300 m before the top of the Agbaja Plateau. Observations during series of field works conducted by the authors in the study area show that the Patti Formation is comparatively texturally and mineralogical matured than the overlying Lokoja Formation. The feldspar content is reduced and the grains are comparatively more rounded. Sedimentary structures in the formation as include wave ripples, slumps, convolute laminations and load cast. Akande *et al*. (2005) documented the presence of the trace fossil *Thallasanoides* in the formation. Jan Du Chene *et al*. (1978) reported the presence of characteristic marine forms (foraminifera) such as *Ammobaculites*, *Textularia* and *Trochamina* in the shale member of the Patti Formation. Observations during field exercise by the present authors at the abandoned mine in Ahoko Village show abundance of land derived forms such as plant and wood remains in the shale member.

Agbaja formation

Completing the simple stratigraphic succession of the southern Bida Basin is the Agbaja Ironstone Formation. This formation outcrops in a sharp bend along the Lokoja -Agbaja road. The Agbaja Formation is characterised by interbeds of sandstones, claystones and massive oolitic ironstone. The sandstone and claystone units of the formation has been interpreted by Ladipo *et al*. (1994) to be abandoned channels and overbanks deposits with marine reworking of units to form massive and oolitic ironstone.

Material and Methods

A total of three hundred and thirty-eight (338) pebble samples recovered from an outcrop section of the Lokoja Formation were available for both macro-morphological (shape) and micro-morphological (surface texture) analyses. Sampling involved in situ removal of pebbles and conglomerates from the outcrop section. Only unbroken pebbles were selected to eliminate ambiguity in the determination of the three axes of measurement. The total length of exposure of the section (road cut) reaches about a hundred meter, with a maximum thickness of seven meters at the center of the outcrop. All the samples were soaked in water for twenty four hours and thoroughly washed to remove sand particles which may adhere to the sample surfaces prior to the commencement of measurement. The long axis (L), intermediate (I) and short axis (S) of the three hundred and thirty eight pebbles were measured using digital Vernier Calliper. On the basis of results obtained from the measurements, form factors such as elongation ratio (E.R), flatness ratio (F.R), oblate-prolate index (OP index), coefficient of flatness (C. F) and maximum projection sphericity index (M.P.S.I) and were calculated using excel spreadsheet. Roundness values of the 338 pebbles were determined using Dobkins and Folk (1970) method. Results of measured parameter and calculated form indices are presented in Tables 1 to 8, appendix. For the micromorphology (surface texture) examinations, 2 samples (samples 90 and 212) were subjected to SEM (Scanning Electron Microscope) at Calgary Rock and Material Services Inc. Canada. The formulae used for the determination of the form indices or form factor are as followed:

Flatness Ratio (Luttig, 1962) S/L………………………(1)

Elongation Ratio (Luttig, 1962) I/L……………………..(2)

Coefficient of Flatness (Luttig, 1962) S/L*100…………(3)

Maximum Projection Sphericity Index (Sneed and Folk, 1958) $[S^2/LI]^{1/3}$ ……(4)
Oplate-Prolate Index (Dobkins and Folk, 1970), 10[L-I/L-S-0.50]S/L……….(5)
Mean = $x = \Sigma x/n$……………………………………………(6)
Where: x = the deviation of each of the numbers from the mean; n = the numbers of samples in a population

Results and Discussion
The lithological log of the studied section is depicted in Fig. 3. Results of the measured parameter and the calculated form indices are presented in Table 1 (Appendix). The total mean; and of all the calculated form indices such as E.R, F.R, M.P.S.I., OP, C.F. and roundness for the pebbles are: 0.786, 0.622, 1.566, 0.195, 62.160 and 0.331, respectively (Table 2).

Table 2: Total mean of pebble morphometric parameters

Formulae	Mean
L{cm}	3.495 ±1.154
S{cm}	2.206 ±2.247
I{cm}	2.735 ±1.021
L-I/L-S	0.543 ±0.265
FLATNESS RATIO S/L	0.625 ±0.362
ELONGATION RATIO I/L	0.788 ±0.144
CO-EFFICIENT OF FLATNESS S/L*100	62.512 ±36.244
MPSI {S^2/LI}^1/3	1.515 ±0.744
OP INDEX 10{L-I/L-S-0.50}S/L	0.179 ±2.423
ROUNDNESS	0.311 ±0.113

Furthermore, scatter plots of the calculated form indices such as M.P.S.I vs OP, C.F. vs M.P.S.I and Roundness vs E.R. were carried out and the results depicted in Figs. 4 to 6, respectively. The Scanning Electron Microscopy (SEM) result of the selected samples are also presented in Figs. 7 to 8.

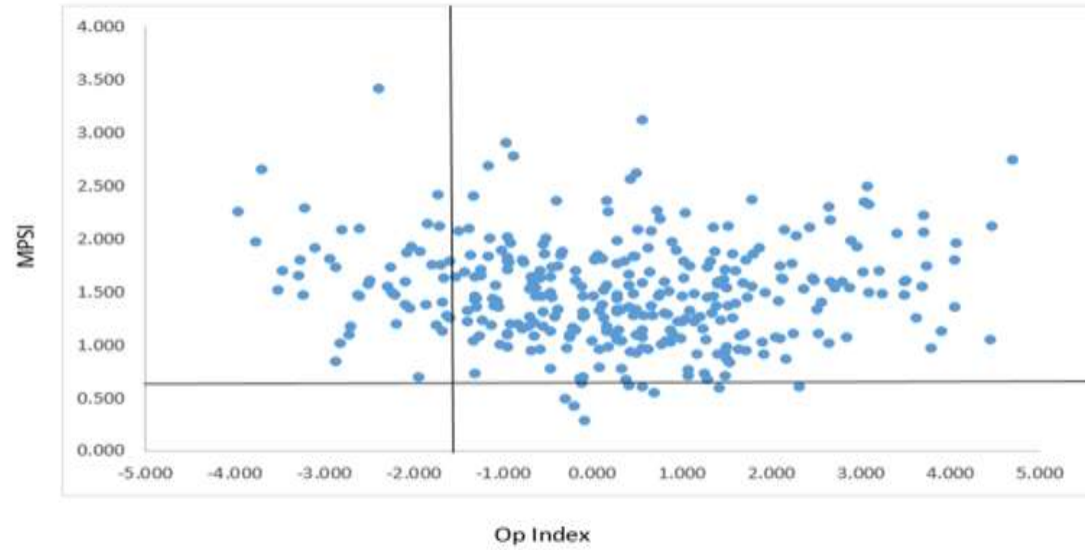

Fig. 4: Plots of sphericity (MPSI) vs Oblate-Prolate (OP) Index for the pebbles of Lokoja Formation

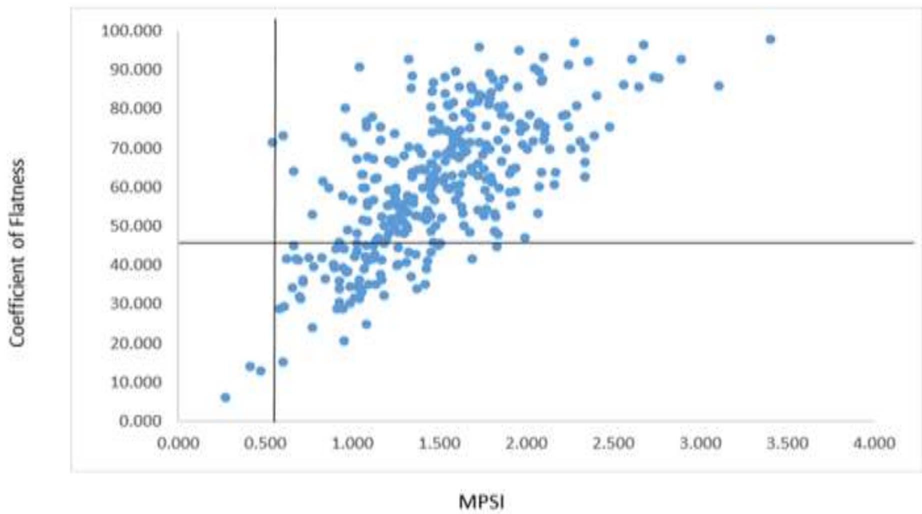

Fig. 5: Plots of Coefficient of Flatness (CF) vs Sphericity (MPSI) for the pebbles of the Lokoja Formation

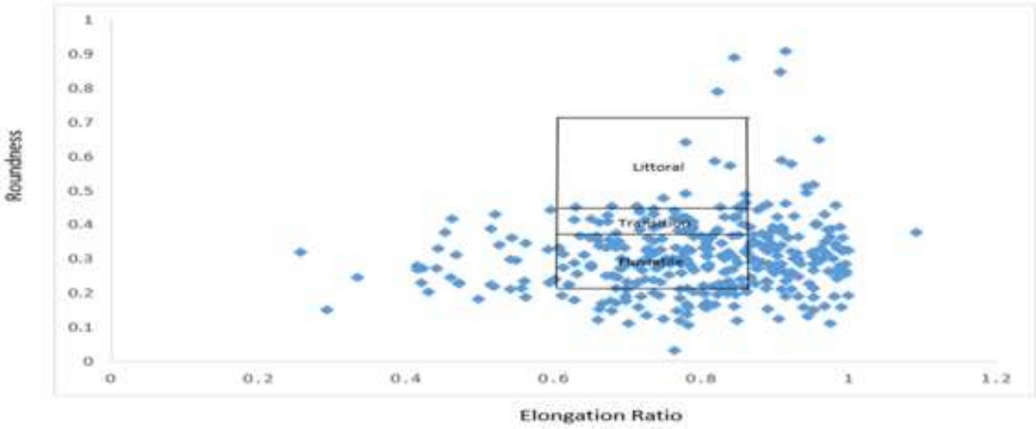

Fig. 6: Plots of Roundnes vs Elongation Ration (ER) for the pebbles of the Lokoja Formation

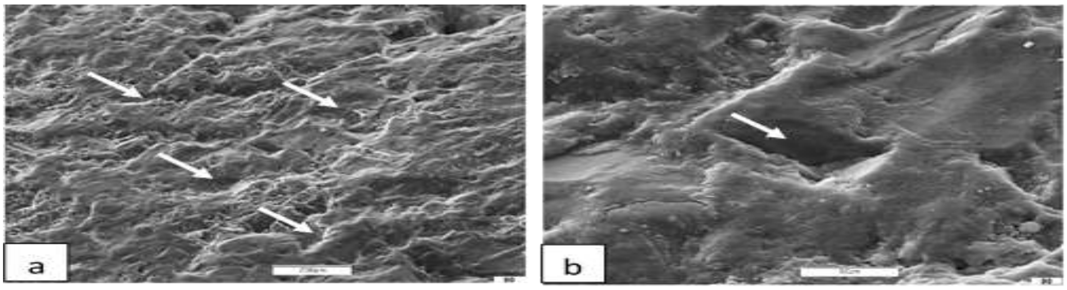

Fig. 7: Image (a) is a low magnification overview of the sample, pitting (arrows) is the result of both chemical and mechanical action. Image (b) is a moderate magnification overview of the sample, the triangular pit (arrow) observed in the center of this image is attributed to impact abrasion features produced in a tumbling environment

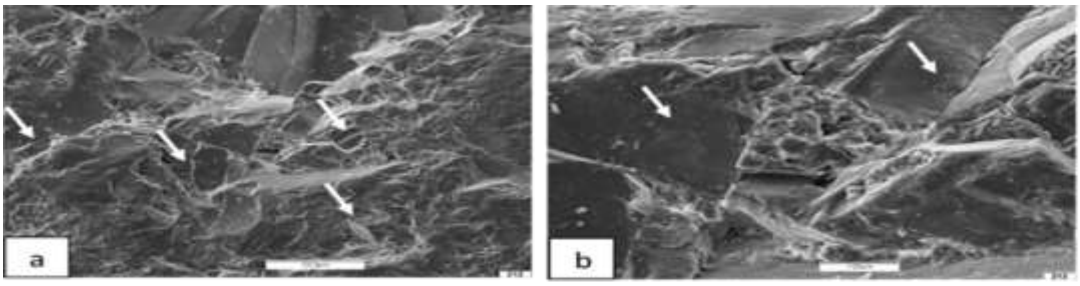

Fig. 8: Image (a) is a low magnification overview of the sample; the sample is dominated by tightly interlocking crystal forms (arrows). Image (b) is a moderate magnification overview of the sample. Note the effects of mechanical abrasion, large concoidal form is shown by the arrow. Concoidal surface features are a clear indication of a mechanical compaction or impact causing fracture

Some groups of pebble form indices have been shown to be good indicators of transport medium and environments from which the clast particles were shaped. Dobkins and Folk (1970) assigned a lower limit of 0.66 as the mean sphericity for fluvially derived pebbles. Also, the mean oblate-prolate index for river pebbles has been suggested by the same authors to be greater than -1.5, whereas lower values indicate beach pebbles. The mean coefficient of flatness as assigned by Stratten (1974) is >45% for pebbles of fluvial origin. Therefore, the above obtained mean values of M.P.S.I, OP and C.F. for the Lokoja Formation fall within river transport sediments.

Of note is the mean roundness value of 0.331 corresponding to 33.1% for the Lokoja Formation. Lower roundness value of pebbles have been attributed to high degree of angularity (Luttig, 1962). Widera (2010) working on the pebbles of the Kozmin South Lignite Open-Cast Pit in Poland assigned roundness value of 0-16% to angular and very angular quartz pebbles. Measured pebble roundness results (Tables 1 – 8) from the present study show that more that 83% of the pebbles of Lokoja Formation ranges from very angular to sub-angular. The remaining 16% plus fall within rounded to sub-rounded. These form classes are indicative of textural immaturity, suggesting deposition close to source. The few samples with high roundness values might result from selective agitated transport of some of the pebbles. The scatter plots of the calculated pebble form indices: M.P.S.I vs O.P, C.F vs M.P.S.I and Roundness vs E.R are represented in figures 4 to 6. Plots of M.P.S.I vs O.P (Fig. 4) indicate that majority of the pebbles fall in the fluvial field. This plot is based on the lower limits of 0.66 for mean sphericity and greater than -1.5 for O.P suggesting fluvial condition (Dobkins and Folk, 1970; Ogala *et al*., 2010a, 2010b; Odumodu and Odumodu, 2012). Plots of C.F against M.P.S.I (Fig. 5) show that majority of the pebbles fall in the fluvial field (Stratten, 1974). The calculated mean coefficient of flatness for the studied pebble is 62%; this is higher than the minimum (45%) for river pebbles (Stratten, 1974). Further, scatter plots of roundness against E.R in Fig. 7 discriminate between littoral and fluviatile fields with majority of the pebbles (70%) plotting within the fluviatile field. Also, greater than 25% fall within the transition between fluviatile and littoral zones.

The two samples (samples 90 and 212) analysed by SEM are not well rounded and not well polished, this reflect the general characteristics of the pebbles of the Lokoja Formation. The morphology of the quartz pebbles show widespread triangular (Figs. 7 – 8) pit and clays that fill the adjacent pits. The triangular pit is most likely the result of mechanical action, where a crystal form has been plucked from the surface of the object or produced in high-energy syn-sedimentary conditions (Widera, 2010). Such actions are more probably found in a fluvial-dominated environment (Gavinchuk and Strom, 2015, personal communication)

Conclusion

On the account of calculated form indices which include mean sphericity, coefficient of flatness and oblate-prolate index obtained for the pebbles of the Lokoja Formation, we draw a conclusion that the pebbles were shaped in a fluvial setting. Scatter plots of sphericity vs oblate-prolate index, coefficient of flatness against sphericity and coefficient of flatness against roundness are also indicative of deposition in a fluvial environment. The calculated mean roundness of 0.331 shows that majority of the pebbles of the Lokoja Formation range from angular to sub-angular, indicating very short transport distance. Micromorphology results from SEM analysis show that the pebbles were deposited in high-energy conditions common to fluvial dominated environments.

Conflict of Interest

Authors have declared that there is no conflict of interest reported in this work.

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APPENDIX

Table 1: Pebble morphology measurement data for the Lokoja formation

S/N	L(cm)	S(cm)	I(cm)	L-I/L-S	Flatness Ratio (F.R.)	Elongation Ratio (E.R.)	Co-efficient of Flatness (C.F.)	MPSI	OP Index	Roundness (%)
1	4.998	2.741	4.702	0.131	0.548	0.941	54.842	1.919	-2.023	51
2	6.656	5.717	6.126	0.564	0.859	0.920	85.892	3.110	0.553	21
3	5.892	4.440	4.575	0.907	0.754	0.776	75.356	2.483	3.067	49
4	4.457	2.746	3.316	0.667	0.616	0.744	61.611	1.777	1.028	23
5	4.740	3.703	3.730	0.974	0.781	0.787	78.122	2.210	3.703	41
6	3.267	2.630	3.101	0.261	0.805	0.949	80.502	1.872	-1.927	31
7	4.310	2.689	3.470	0.518	0.624	0.805	62.390	1.799	0.114	16
8	3.677	2.350	3.272	0.305	0.639	0.890	63.911	1.700	-1.245	15
9	6.130	0.920	1.563	0.877	0.150	0.255	15.008	0.600	0.565	32
10	2.660	1.483	1.596	0.904	0.558	0.600	55.752	1.097	2.252	24
11	1.720	1.340	1.340	1.000	0.779	0.779	77.907	1.118	3.895	39
12	4.426	2.703	3.554	0.506	0.611	0.803	61.071	1.804	0.037	16
13	3.210	2.250	2.500	0.740	0.701	0.779	70.093	1.580	1.679	30
14	3.265	1.458	1.994	0.703	0.447	0.611	44.655	1.091	0.908	19
15	5.567	3.247	3.667	0.819	0.583	0.659	58.326	1.908	1.860	35
16	4.672	3.245	4.335	0.236	0.695	0.928	69.456	2.138	-1.833	32
17	4.058	3.735	3.834	0.693	0.920	0.945	92.040	2.362	1.781	23
18	5.406	3.762	4.413	0.604	0.696	0.816	69.589	2.261	0.724	17
19	6.116	2.959	4.227	0.598	0.484	0.691	48.381	1.822	0.476	27
20	4.406	1.377	2.616	0.591	0.313	0.594	31.253	1.040	0.284	44
21	2.921	1.346	2.400	0.331	0.461	0.822	46.080	1.142	-0.780	20
22	4.331	2.302	3.576	0.372	0.532	0.826	53.152	1.636	-0.680	45
23	1.232	1.116	1.117	0.991	0.906	0.907	90.584	1.041	4.451	34
24	0.615	0.439	0.510	0.597	0.714	0.829	71.382	0.543	0.689	26
25	3.912	2.721	3.023	0.746	0.696	0.773	69.555	1.789	1.714	42
26	5.000	2.936	4.287	0.345	0.587	0.857	58.720	1.948	-0.908	32
27	3.004	1.789	2.614	0.321	0.596	0.870	59.554	1.407	-1.066	30
28	5.711	3.641	4.429	0.619	0.638	0.776	63.754	2.174	0.761	42
29	3.311	1.328	1.370	0.979	0.401	0.414	40.109	0.900	1.920	28
30	2.744	2.333	2.467	0.674	0.850	0.899	85.022	1.698	1.479	33
31	3.445	1.839	2.312	0.705	0.534	0.671	53.382	1.314	1.097	25
32	4.345	3.020	3.863	0.364	0.695	0.889	69.505	2.009	-0.947	46
33	6.044	4.227	4.347	0.934	0.699	0.719	69.937	2.342	3.035	27
34	3.950	2.597	3.009	0.695	0.657	0.762	65.747	1.726	1.285	3
35	5.182	1.816	4.564	0.184	0.350	0.881	35.044	1.427	-1.109	29
36	4.799	1.445	2.256	0.758	0.301	0.470	30.110	0.994	0.777	23
37	5.944	1.998	3.839	0.533	0.336	0.646	33.614	1.371	0.112	36
38	4.096	1.436	2.910	0.446	0.351	0.710	35.059	1.136	-0.190	45
39	3.619	2.514	3.217	0.364	0.695	0.889	69.467	1.778	-0.946	23
40	3.915	2.006	2.857	0.554	0.512	0.730	51.239	1.432	0.278	32
41	4.339	2.559	3.682	0.369	0.590	0.849	58.977	1.771	-0.772	45
42	4.288	1.859	3.809	0.197	0.434	0.888	43.354	1.453	-1.313	36
43	3.145	2.221	2.766	0.410	0.706	0.879	70.620	1.631	-0.634	37
44	2.485	1.853	2.467	0.028	0.746	0.993	74.567	1.505	-3.516	26
45	3.116	2.523	2.793	0.545	0.810	0.896	80.969	1.787	0.362	39
46	3.730	2.260	3.136	0.404	0.606	0.841	60.590	1.625	-0.581	27
47	4.004	1.211	2.220	0.639	0.302	0.554	30.245	0.933	0.420	22
48	3.933	1.587	3.568	0.156	0.404	0.907	40.351	1.317	-1.390	59
49	3.018	1.351	2.357	0.397	0.448	0.781	44.765	1.125	-0.463	11
50	4.413	1.421	3.691	0.241	0.322	0.836	32.200	1.191	-0.833	57
51	3.818	2.008	2.909	0.502	0.526	0.762	52.593	1.454	0.012	44
52	3.844	1.289	2.752	0.427	0.335	0.716	33.533	1.060	-0.243	29
53	4.645	2.632	2.755	0.939	0.567	0.593	56.663	1.602	2.487	23
54	1.675	1.554	1.641	0.281	0.928	0.980	92.776	1.332	-2.032	19
55	3.707	2.328	3.513	0.141	0.628	0.948	62.800	1.725	-2.257	32
56	3.503	1.950	2.301	0.774	0.557	0.657	55.667	1.357	1.525	37

57	5.733	4.100	4.210	0.933	0.715	0.734	71.516	2.311	3.094	39
58	2.872	2.140	2.669	0.277	0.745	0.929	74.513	1.621	-1.659	25
59	3.478	1.777	2.357	0.659	0.511	0.678	51.093	1.289	0.812	25
60	2.840	2.361	2.704	0.284	0.831	0.952	83.134	1.744	-1.796	22
61	3.188	2.632	2.637	0.991	0.826	0.827	82.560	1.789	4.054	21
62	2.568	2.206	2.533	0.097	0.859	0.986	85.903	1.687	-3.465	28
63	4.241	2.316	3.445	0.414	0.546	0.812	54.610	1.633	-0.472	22
64	3.550	2.419	3.265	0.252	0.681	0.920	68.141	1.752	-1.690	58
65	4.643	1.810	4.164	0.169	0.390	0.897	38.983	1.432	-1.290	26
66	3.426	2.590	2.861	0.676	0.756	0.835	75.598	1.776	1.329	21
67	2.633	1.571	2.121	0.482	0.597	0.806	59.666	1.257	-0.107	31
68	4.031	2.605	3.257	0.543	0.646	0.808	64.624	1.763	0.276	34
69	3.483	2.199	3.151	0.259	0.631	0.905	63.135	1.635	-1.524	27
70	2.409	1.419	2.147	0.265	0.589	0.891	58.904	1.215	-1.386	29
71	3.814	2.154	2.651	0.701	0.565	0.695	56.476	1.477	1.133	34
72	2.863	2.503	2.722	0.392	0.874	0.951	87.426	1.813	-0.947	15
73	3.275	2.354	2.367	0.986	0.719	0.723	71.878	1.588	3.492	41
74	3.435	2.316	2.706	0.651	0.674	0.788	67.424	1.617	1.021	37
75	4.202	1.463	2.633	0.573	0.348	0.627	34.817	1.103	0.254	18
76	4.670	2.132	3.248	0.560	0.457	0.696	45.653	1.468	0.275	28
77	3.370	2.709	2.892	0.723	0.804	0.858	80.386	1.847	1.794	46
78	3.059	1.971	2.594	0.427	0.644	0.848	64.433	1.488	-0.468	12
79	3.500	2.093	2.390	0.789	0.598	0.683	59.800	1.441	1.728	34
80	2.547	1.331	2.343	0.168	0.523	0.920	52.258	1.177	-1.736	26
81	2.711	2.139	2.663	0.084	0.789	0.982	78.901	1.650	-3.283	34
82	2.508	2.043	2.395	0.243	0.815	0.955	81.459	1.586	-2.093	40
83	1.410	0.585	1.021	0.472	0.415	0.724	41.489	0.628	-0.118	33
84	0.728	0.530	0.566	0.818	0.728	0.777	72.802	0.602	2.316	42
85	5.509	4.842	4.819	1.034	0.879	0.875	87.893	2.737	4.698	44
86	4.188	2.715	2.724	0.994	0.648	0.650	64.828	1.686	3.202	42
87	6.449	3.033	5.573	0.256	0.470	0.864	47.031	1.996	-1.145	34
88	2.897	2.412	2.591	0.631	0.833	0.894	83.259	1.733	1.090	33
89	3.203	2.190	2.613	0.582	0.684	0.816	68.373	1.576	0.564	38
90	3.026	1.422	2.300	0.453	0.470	0.760	46.993	1.154	-0.223	30
91	4.338	3.315	3.538	0.782	0.764	0.816	76.418	2.077	2.155	59
92	3.507	1.754	2.600	0.517	0.500	0.741	50.014	1.316	0.087	28
93	4.224	2.550	2.612	0.963	0.604	0.618	60.369	1.590	2.795	22
94	2.823	0.897	1.207	0.839	0.318	0.428	31.775	0.701	1.077	20
95	3.501	2.378	2.587	0.814	0.679	0.739	67.923	1.611	2.132	27
96	3.199	2.179	2.226	0.954	0.681	0.696	68.115	1.489	3.092	21
97	3.415	2.350	2.820	0.559	0.688	0.826	68.814	1.658	0.404	31
98	4.412	2.926	3.362	0.707	0.663	0.762	66.319	1.869	1.370	42
99	4.033	1.952	3.267	0.368	0.484	0.810	48.401	1.456	-0.638	28
100	3.040	2.086	2.580	0.482	0.686	0.849	68.618	1.546	-0.122	37
101	4.617	3.840	4.390	0.292	0.832	0.951	83.171	2.411	-1.729	52
102	5.103	2.662	4.422	0.279	0.522	0.867	52.165	1.831	-1.153	25
103	5.006	3.191	4.488	0.285	0.637	0.897	63.744	2.090	-1.368	34
104	3.651	1.858	2.283	0.763	0.509	0.625	50.890	1.292	1.338	42
105	3.572	2.546	2.624	0.924	0.713	0.735	71.277	1.682	3.022	32
106	3.352	1.790	2.427	0.592	0.534	0.724	53.401	1.324	0.492	14
107	5.965	2.842	4.630	0.427	0.476	0.776	47.645	1.844	-0.346	64
108	3.444	2.155	2.936	0.394	0.626	0.852	62.573	1.582	-0.663	24
109	6.627	4.015	4.173	0.940	0.606	0.630	60.585	2.165	2.663	45
110	2.602	1.973	2.277	0.517	0.758	0.875	75.826	1.505	0.127	27
111	2.266	1.353	1.558	0.775	0.597	0.688	59.709	1.080	1.645	27
112	2.309	1.431	1.694	0.700	0.620	0.734	61.975	1.145	1.242	20
113	1.577	1.186	1.431	0.373	0.752	0.907	75.206	1.085	-0.952	21
114	4.177	1.562	2.754	0.544	0.374	0.659	37.395	1.172	0.165	12

115	3.418	3.081	3.111	0.911	0.901	0.910	90.140	2.052	3.705	39
116	3.117	1.457	2.519	0.360	0.467	0.808	46.744	1.197	-0.653	31
117	3.196	2.013	2.519	0.572	0.630	0.788	62.985	1.473	0.455	20
118	2.861	1.299	2.833	0.018	0.454	0.990	45.404	1.187	-2.189	36
119	2.892	1.999	2.769	0.138	0.691	0.957	69.122	1.564	-2.504	29
120	5.463	1.112	3.889	0.362	0.204	0.712	20.355	0.958	-0.281	23
121	3.333	2.610	3.163	0.235	0.783	0.949	78.308	1.863	-2.074	27
122	2.250	1.500	1.768	0.643	0.667	0.786	66.667	1.209	0.951	28
123	2.929	0.844	0.854	0.995	0.288	0.292	28.815	0.592	1.427	15
124	3.672	1.476	3.464	0.095	0.402	0.943	40.196	1.271	-1.629	13
125	4.723	2.991	3.684	0.600	0.633	0.780	63.328	1.911	0.633	38
126	4.245	3.211	3.638	0.587	0.756	0.857	75.642	2.067	0.658	49
127	3.618	1.743	2.453	0.621	0.482	0.678	48.176	1.272	0.585	46
128	4.470	1.640	4.048	0.149	0.367	0.906	36.689	1.345	-1.287	29
129	4.893	2.544	2.653	0.954	0.520	0.542	51.993	1.520	2.358	36
130	3.886	1.396	1.612	0.913	0.359	0.415	35.924	0.932	1.485	27
131	3.065	2.385	2.585	0.706	0.778	0.843	77.814	1.687	1.602	22
132	3.628	2.757	3.623	0.006	0.760	0.999	75.992	1.965	-3.756	19
133	4.302	3.037	3.621	0.538	0.706	0.842	70.595	1.980	0.271	16
134	2.654	1.554	2.183	0.428	0.586	0.823	58.553	1.257	-0.421	23
135	4.633	2.759	3.864	0.410	0.596	0.834	59.551	1.852	-0.534	23
136	2.947	2.794	2.856	0.595	0.948	0.969	94.808	1.963	0.899	38
137	5.717	3.426	4.379	0.584	0.599	0.766	59.927	2.079	0.504	15
138	1.491	0.669	1.010	0.585	0.449	0.677	44.869	0.672	0.382	15
139	2.972	0.177	1.995	0.350	0.060	0.671	5.956	0.276	-0.090	33
140	4.797	3.615	4.178	0.524	0.754	0.871	75.360	2.249	0.179	23
141	3.277	1.630	2.410	0.526	0.497	0.735	49.741	1.250	0.131	43
142	4.588	4.422	4.525	0.380	0.964	0.986	96.382	2.682	-1.161	27
143	4.660	4.317	4.470	0.554	0.926	0.959	92.639	2.615	0.500	33
144	6.312	3.930	5.275	0.435	0.623	0.836	62.262	2.346	-0.403	32
145	3.516	1.683	2.217	0.709	0.479	0.631	47.867	1.213	0.999	26
146	3.966	1.438	3.090	0.347	0.363	0.779	36.258	1.172	-0.556	33
147	3.077	2.219	2.480	0.696	0.721	0.806	72.116	1.583	1.412	17
148	4.707	2.564	4.000	0.330	0.545	0.850	54.472	1.774	-0.927	29
149	3.004	0.378	2.315	0.262	0.126	0.771	12.583	0.479	-0.299	42
150	4.151	2.889	3.349	0.635	0.696	0.807	69.598	1.888	0.943	36
151	5.068	4.336	5.018	0.068	0.856	0.990	85.556	2.650	-3.693	32
152	3.024	2.501	2.526	0.952	0.827	0.835	82.705	1.735	3.740	27
153	4.526	2.932	3.864	0.415	0.648	0.854	64.781	1.943	-0.549	40
154	2.406	2.306	2.360	0.460	0.958	0.981	95.844	1.734	-0.383	34
155	2.825	1.410	2.378	0.316	0.499	0.842	49.912	1.187	-0.919	89
156	3.234	2.318	2.436	0.871	0.717	0.753	71.676	1.594	2.660	26
157	3.050	1.194	1.563	0.801	0.391	0.512	39.148	0.901	1.179	39
158	2.089	1.807	2.020	0.245	0.865	0.967	86.501	1.467	-2.209	32
159	3.032	2.275	2.798	0.309	0.750	0.923	75.033	1.684	-1.432	30
160	3.335	2.051	2.825	0.397	0.615	0.847	61.499	1.527	-0.632	42
161	3.792	2.371	2.426	0.961	0.625	0.640	62.526	1.532	2.884	31
162	3.383	3.031	3.317	0.188	0.896	0.980	89.595	2.081	-2.800	46
163	4.260	1.223	2.211	0.675	0.287	0.519	28.709	0.919	0.501	43
164	3.670	3.204	3.307	0.779	0.873	0.901	87.302	2.099	2.435	42
165	3.702	2.203	2.848	0.570	0.595	0.769	59.508	1.551	0.415	19
166	4.033	3.162	3.345	0.790	0.784	0.829	78.403	2.024	2.273	30
167	3.330	1.365	2.891	0.223	0.410	0.868	40.991	1.174	-1.134	29
168	3.266	1.024	1.086	0.972	0.314	0.333	31.353	0.704	1.481	25
169	4.082	1.802	2.591	0.654	0.441	0.635	44.145	1.273	0.680	37
170	2.313	2.073	2.198	0.479	0.896	0.950	89.624	1.598	-0.187	29
171	2.830	1.458	2.470	0.262	0.515	0.873	51.519	1.229	-1.224	27
172	3.428	1.464	2.307	0.571	0.427	0.673	42.707	1.130	0.302	43

173	2.793	2.057	2.077	0.973	0.736	0.744	73.648	1.465	3.482	33
174	2.431	1.966	2.330	0.217	0.809	0.958	80.872	1.547	-2.287	65
175	2.801	1.920	2.093	0.804	0.685	0.747	68.547	1.402	2.081	48
176	2.868	1.470	1.610	0.900	0.513	0.561	51.255	1.066	2.049	19
177	3.387	1.705	2.199	0.706	0.503	0.649	50.340	1.236	1.039	28
178	2.328	1.115	2.057	0.223	0.479	0.884	47.895	1.032	-1.325	33
179	2.504	1.416	1.791	0.655	0.565	0.715	56.550	1.128	0.878	44
180	5.808	2.410	4.883	0.272	0.415	0.841	41.494	1.697	-0.945	37
181	1.408	0.577	1.384	0.029	0.410	0.983	40.980	0.689	-1.931	25
182	2.902	1.314	1.821	0.681	0.453	0.627	45.279	1.027	0.818	29
183	3.013	1.665	1.987	0.761	0.553	0.659	55.261	1.223	1.443	41
184	3.920	2.118	2.590	0.738	0.540	0.661	54.031	1.436	1.286	15
185	3.122	1.632	2.401	0.484	0.523	0.769	52.274	1.270	-0.084	12
186	2.378	1.616	2.009	0.484	0.680	0.845	67.956	1.302	-0.107	20
187	2.222	1.630	1.634	0.993	0.734	0.735	73.357	1.250	3.618	24
188	2.727	1.249	1.431	0.877	0.458	0.525	45.801	0.935	1.726	34
189	1.324	1.058	1.065	0.974	0.799	0.804	79.909	0.966	3.785	20
190	1.705	1.282	1.645	0.142	0.752	0.965	75.191	1.166	-2.693	43
191	2.943	1.701	1.986	0.771	0.578	0.675	57.798	1.250	1.564	36
192	1.825	1.613	1.744	0.382	0.884	0.956	88.384	1.355	-1.042	41
193	2.850	2.066	2.726	0.158	0.725	0.956	72.491	1.598	-2.478	30
194	2.215	1.368	1.715	0.590	0.618	0.774	61.761	1.132	0.558	32
195	3.180	1.242	2.535	0.333	0.391	0.797	39.057	1.071	-0.653	37
196	3.672	1.834	3.574	0.053	0.499	0.973	49.946	1.485	-2.231	26
197	1.417	0.750	1.143	0.411	0.529	0.807	52.929	0.768	-0.472	28
198	1.627	1.161	1.221	0.871	0.714	0.750	71.358	1.004	2.649	30
199	5.216	2.336	3.227	0.691	0.448	0.619	44.785	1.500	0.854	23
200	0.948	0.606	0.784	0.480	0.639	0.827	63.924	0.672	-0.131	35
201	3.003	2.489	2.794	0.407	0.829	0.930	82.884	1.793	-0.774	30
202	2.338	0.325	1.630	0.352	0.139	0.697	13.901	0.419	-0.206	18
203	3.164	1.659	2.944	0.146	0.524	0.930	52.434	1.368	-1.855	19
204	4.851	1.972	3.734	0.388	0.407	0.770	40.651	1.441	-0.455	21
205	1.981	1.247	1.548	0.590	0.629	0.781	62.948	1.067	0.566	16
206	2.388	1.589	1.848	0.676	0.665	0.774	66.541	1.250	1.170	30
207	4.264	3.156	3.277	0.891	0.740	0.769	74.015	1.971	2.892	38
208	2.622	2.015	2.062	0.923	0.768	0.786	76.850	1.473	3.247	38
209	3.992	0.951	2.046	0.640	0.238	0.513	23.823	0.774	0.333	22
210	4.516	2.261	3.950	0.251	0.501	0.875	50.066	1.647	-1.247	35
211	2.622	1.833	2.046	0.730	0.699	0.780	69.908	1.379	1.608	22
212	3.399	3.172	3.177	0.978	0.933	0.935	93.322	2.111	4.461	29
213	2.164	1.054	1.826	0.305	0.487	0.844	48.706	0.979	-0.952	42
214	4.679	2.528	3.784	0.416	0.540	0.809	54.029	1.729	-0.453	33
215	5.537	2.664	3.720	0.632	0.481	0.672	48.113	1.683	0.637	41
216	4.785	1.510	2.245	0.776	0.316	0.469	31.557	1.023	0.870	23
217	2.558	1.070	1.270	0.866	0.418	0.496	41.830	0.828	1.529	18
218	2.706	1.783	2.609	0.105	0.659	0.964	65.891	1.453	-2.602	30
219	3.944	2.336	2.758	0.738	0.592	0.699	59.229	1.563	1.407	11
220	5.070	3.275	3.350	0.958	0.646	0.661	64.596	1.921	2.960	34
221	1.625	0.671	1.173	0.474	0.413	0.722	41.292	0.688	-0.108	24
222	5.508	1.359	3.850	0.400	0.247	0.699	24.673	1.089	-0.248	23
223	3.574	3.467	3.556	0.168	0.970	0.995	97.006	2.287	-3.218	26
224	3.535	3.070	3.442	0.200	0.868	0.974	86.846	2.094	-2.605	37
225	2.723	1.540	2.276	0.378	0.566	0.836	56.555	1.256	-0.691	32
226	4.483	3.377	3.706	0.703	0.753	0.827	75.329	2.113	1.526	21
227	2.735	1.802	2.639	0.103	0.659	0.965	65.887	1.463	-2.616	16
228	2.684	1.179	1.452	0.819	0.439	0.541	43.927	0.909	1.400	30
229	4.709	3.790	3.947	0.829	0.805	0.838	80.484	2.292	2.649	21
230	2.408	2.014	2.140	0.680	0.836	0.889	83.638	1.533	1.507	32

231	4.957	1.973	2.567	0.801	0.398	0.518	39.802	1.263	1.198	22
232	2.208	1.449	2.012	0.258	0.656	0.911	65.625	1.241	-1.587	26
233	1.858	1.335	1.649	0.400	0.719	0.888	71.851	1.165	-0.721	21
234	1.977	1.685	1.692	0.976	0.852	0.856	85.230	1.344	4.057	22
235	2.977	2.219	2.223	0.995	0.745	0.747	74.538	1.543	3.688	13
236	2.814	2.288	2.589	0.428	0.813	0.920	81.308	1.689	-0.587	32
237	2.843	1.190	2.516	0.198	0.419	0.885	41.857	1.078	-1.265	23
238	3.103	2.005	2.119	0.896	0.646	0.683	64.615	1.400	2.560	22
239	1.702	1.142	1.422	0.500	0.671	0.835	67.098	1.029	0.000	23
240	4.568	3.586	3.946	0.633	0.785	0.864	78.503	2.231	1.047	39
241	2.922	2.450	2.851	0.150	0.838	0.976	83.847	1.803	-2.931	39
242	2.111	0.881	1.179	0.758	0.417	0.559	41.734	0.757	1.076	23
243	3.277	2.021	2.444	0.663	0.617	0.746	61.672	1.450	1.007	36
244	3.900	1.334	2.384	0.591	0.342	0.611	34.205	1.028	0.311	28
245	2.838	1.769	2.233	0.566	0.623	0.787	62.333	1.350	0.411	40
246	3.030	2.643	2.851	0.463	0.872	0.941	87.228	1.873	-0.327	49
247	1.795	0.640	1.640	0.134	0.357	0.914	35.655	0.721	-1.304	19
248	3.025	1.745	2.312	0.557	0.577	0.764	57.686	1.325	0.329	34
249	1.788	1.013	1.786	0.003	0.567	0.999	56.655	1.008	-2.818	33
250	3.639	2.705	3.300	0.363	0.743	0.907	74.334	1.879	-1.019	38
251	1.415	1.028	1.192	0.576	0.727	0.842	72.650	0.962	0.554	31
252	1.515	1.158	1.463	0.146	0.764	0.966	76.436	1.090	-2.708	35
253	1.850	1.241	1.697	0.251	0.671	0.917	67.081	1.122	-1.669	36
254	5.402	5.000	5.243	0.396	0.926	0.971	92.558	2.895	-0.967	26
255	3.098	1.061	2.693	0.199	0.342	0.869	34.248	0.993	-1.031	37
256	3.652	2.600	2.815	0.796	0.712	0.771	71.194	1.734	2.105	26
257	2.990	2.318	2.670	0.476	0.775	0.893	77.525	1.687	-0.185	27
258	4.331	3.187	4.024	0.268	0.736	0.929	73.586	2.113	-1.705	37
259	3.623	1.042	2.859	0.296	0.288	0.789	28.761	0.950	-0.587	27
260	5.303	3.869	4.847	0.318	0.730	0.914	72.959	2.392	-1.328	46
261	3.218	2.205	2.905	0.309	0.685	0.903	68.521	1.637	-1.309	13
262	4.822	1.593	2.244	0.798	0.330	0.465	33.036	1.057	0.986	31
263	2.538	1.780	1.888	0.858	0.701	0.744	70.134	1.331	2.507	29
264	2.757	2.143	2.386	0.604	0.777	0.865	77.729	1.584	0.810	39
265	5.416	2.885	3.933	0.586	0.533	0.726	53.268	1.822	0.458	29
266	3.361	1.917	2.286	0.744	0.570	0.680	57.037	1.357	1.394	34
267	3.643	2.620	3.324	0.312	0.719	0.912	71.919	1.843	-1.353	23
268	2.814	2.303	2.737	0.151	0.818	0.973	81.841	1.728	-2.859	11
269	4.792	3.426	3.459	0.976	0.715	0.722	71.494	2.039	3.402	30
270	4.352	1.578	1.996	0.849	0.363	0.459	36.259	1.045	1.267	25
271	3.430	2.667	3.352	0.102	0.778	0.977	77.755	1.908	-3.093	30
272	2.979	1.652	2.448	0.400	0.555	0.822	55.455	1.309	-0.554	79
273	3.802	1.439	1.677	0.899	0.378	0.441	37.849	0.970	1.511	33
274	4.256	2.474	2.916	0.752	0.581	0.685	58.130	1.613	1.465	25
275	2.102	0.829	1.442	0.518	0.394	0.686	39.439	0.778	0.073	35
276	3.520	2.178	2.430	0.812	0.619	0.690	61.875	1.485	1.932	30
277	3.276	1.956	2.640	0.482	0.597	0.806	59.707	1.455	-0.109	35
278	3.344	2.215	2.475	0.770	0.662	0.740	66.238	1.537	1.786	32
279	3.090	2.646	2.787	0.682	0.856	0.902	85.631	1.848	1.562	31
280	2.444	0.830	1.027	0.878	0.340	0.420	33.961	0.662	1.284	27
281	3.274	2.350	2.540	0.794	0.718	0.776	71.778	1.624	2.113	38
282	3.490	1.715	2.742	0.421	0.491	0.786	49.140	1.322	-0.386	32
283	2.789	1.794	2.495	0.295	0.643	0.895	64.324	1.423	-1.316	38
284	5.936	3.117	3.325	0.926	0.525	0.560	52.510	1.759	2.238	35
285	2.492	0.901	1.147	0.845	0.362	0.460	36.156	0.720	1.249	42
286	2.927	1.271	1.976	0.574	0.434	0.675	43.423	1.029	0.323	18
287	6.005	3.964	4.933	0.525	0.660	0.821	66.012	2.346	0.167	39
288	4.034	1.717	3.470	0.243	0.426	0.860	42.563	1.364	-1.092	32

289	2.556	2.187	2.265	0.789	0.856	0.886	85.563	1.618	2.470	34
290	3.073	1.677	2.259	0.583	0.546	0.735	54.572	1.274	0.453	45
291	2.080	1.310	1.438	0.834	0.630	0.691	62.981	1.059	2.102	30
292	2.114	1.785	2.075	0.119	0.844	0.982	84.437	1.462	-3.221	26
293	1.854	1.073	1.379	0.608	0.579	0.744	57.875	0.950	0.626	40
294	3.545	1.386	1.559	0.920	0.391	0.440	39.097	0.945	1.642	27
295	4.737	2.705	3.708	0.506	0.571	0.783	57.104	1.789	0.037	32
296	2.361	1.408	1.431	0.976	0.596	0.606	59.636	1.063	2.838	33
297	1.265	0.777	1.249	0.033	0.614	0.987	61.423	0.842	-2.870	16
298	2.328	1.868	2.055	0.593	0.802	0.883	80.241	1.455	0.750	45
299	3.357	2.047	2.539	0.624	0.610	0.756	60.977	1.469	0.759	29
300	2.539	2.047	2.283	0.520	0.806	0.899	80.622	1.556	0.164	28
301	4.718	3.400	3.811	0.688	0.721	0.808	72.064	2.106	1.356	27
302	3.054	1.249	2.572	0.267	0.409	0.842	40.897	1.095	-0.953	42
303	2.519	1.104	1.786	0.518	0.438	0.709	43.827	0.952	0.079	23
304	3.096	1.186	2.053	0.546	0.383	0.663	38.307	0.977	0.176	17
305	4.024	1.367	2.464	0.587	0.340	0.612	33.971	1.046	0.296	31
306	2.744	2.036	2.493	0.355	0.742	0.909	74.198	1.556	-1.079	39
307	3.440	2.944	2.956	0.976	0.856	0.859	85.581	1.953	4.072	20
308	2.427	1.331	1.781	0.589	0.548	0.734	54.841	1.091	0.490	35
309	3.338	1.924	2.770	0.402	0.576	0.830	57.639	1.454	-0.567	42
310	3.485	1.442	2.381	0.540	0.414	0.683	41.377	1.124	0.167	17
311	2.715	2.416	2.675	0.134	0.890	0.985	88.987	1.792	-3.259	39
312	3.211	1.738	2.244	0.656	0.541	0.699	54.126	1.283	0.847	29
313	4.570	2.071	3.704	0.347	0.453	0.811	45.317	1.515	-0.695	36
314	4.297	1.857	2.920	0.564	0.432	0.680	43.216	1.328	0.278	25
315	2.585	1.664	2.423	0.176	0.644	0.937	64.371	1.374	-2.086	16
316	1.673	0.996	1.088	0.864	0.595	0.650	59.534	0.864	2.168	28
317	3.508	2.477	3.226	0.274	0.706	0.920	70.610	1.780	-1.599	25
318	2.913	1.605	1.988	0.707	0.551	0.682	55.098	1.207	1.142	38
319	2.181	0.643	1.195	0.641	0.295	0.548	29.482	0.610	0.416	30
320	2.997	1.007	2.406	0.297	0.336	0.803	33.600	0.934	-0.682	34
321	2.806	1.785	2.190	0.603	0.636	0.780	63.614	1.355	0.657	17
322	2.928	1.494	1.731	0.835	0.510	0.591	51.025	1.097	1.708	33
323	2.270	2.000	2.052	0.807	0.881	0.904	88.106	1.535	2.708	85
324	5.391	4.724	5.125	0.399	0.876	0.951	87.628	2.768	-0.887	19
325	4.954	4.261	4.573	0.550	0.860	0.923	86.011	2.559	0.428	43
326	3.206	2.360	2.380	0.976	0.736	0.742	73.612	1.605	3.507	19
327	3.681	1.766	2.612	0.558	0.480	0.710	47.976	1.303	0.279	28
328	3.978	2.994	3.553	0.432	0.753	0.893	75.264	2.001	-0.512	35
329	5.904	3.141	5.293	0.221	0.532	0.897	53.201	2.068	-1.484	34
330	3.328	1.733	3.041	0.180	0.521	0.914	52.073	1.400	-1.667	91
331	3.713	3.378	3.691	0.066	0.910	0.994	90.978	2.247	-3.951	29
332	3.350	1.223	1.406	0.914	0.365	0.420	36.507	0.856	1.511	23
333	3.659	1.541	1.647	0.950	0.421	0.450	42.115	1.022	1.895	38
334	3.331	2.057	2.416	0.718	0.618	0.725	61.753	1.453	1.348	33
335	1.999	1.352	1.434	0.873	0.676	0.717	67.634	1.095	2.525	19
336	6.207	39.780	6.770	0.017	6.409	1.091	640.889	11.995	-30.970	38
337	6.463	6.306	6.423	0.255	0.976	0.994	97.571	3.406	-2.393	33
338	6.654	2.950	4.750	0.514	0.443	0.714	44.334	1.838	0.062	16