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PROVENANCE OF KARAKUM DESERT SAND (TURKMENISTAN): LITHIC-RICH OROGENIC SIGNATURE OF CENTRAL ASIAN DUNE FIELDS

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Supplementary material

Sample	River / Desert	Site	Facies	Country	Collected by	Year	Latitude	Longitude
S4748	Panj	Kishti Poyen	sandy river bar	Tajikistan	Paolo Ballato	2013	37°56'45" N	70°11'30" E
S4749	Yakhsu	Dara-Khurdak	sandy river bar	Tajikistan	Paolo Ballato	2013	38°26'30" N	70°02'30" E
S4751	Khingou	Obikhingob	sandy river bar	Tajikistan	Paolo Ballato	2013	38°52'00" N	70°02'00" E
S4750	Vakhsh	Chumdon	sandy river bar	Tajikistan	Paolo Ballato	2013	38°52'30" N	70°03'00" E
S4632	Syr Darya	Buramatutu	silty river levee	Uzbekistan	P.Krugmier/G.M.Zanderighi	2009	40°53'00" N	71°26'30" E
S3463	Hari	Gush Sargousi	sandy river bar	Iran	Eduardo Garzanti	2005	36°21'59" N	61°09'01" E
S5335	Karakum	Ashk-Abad	eolian dune	Turkmenistan	Saeid Sabouri	2017	38°04'00" N	58°21'30" E
S419	Karakum	Orfa	eolian dune	Turkmenistan	Eduardo Garzanti	1997	40°16'00" N	54°12'00" E
S418	Karakum	Tuar	eolian dune	Turkmenistan	Eduardo Garzanti	1997	40°50'30" N	55°11'00" E

Tab. A1 - Information on modern sediment samples. Location of the studied fluvial and eolian sediments is indicated also in the Google EarthTM file Turkmen.kmz.

River	Site	Sample	Operator	GSZ	Q	KF	P	Lvf	Lvm	Lcc	Lcd	Lp	Lh	Lms	Lmv	Lmf	Lmb	Lu	mica	HM		Q	F	L		Lm	Lv	Ls		Qp/Q	P/F	Mic/F	MI*	MI
Panj	Kishti Poyen	S4748	A.Resentini	110	40	5	12	0,3	1	11	4	3	----	7	1	4	0,5	0,3	3	8	100,0	46	19	36	100,0	26	5	69	100,0	0,12	0,70	0,05	224	165
Yakhsu	Dara-Khurdak	S4749	A.Resentini	180	11	0,3	2	----	----	52	10	1	----	14	1	6	0,3	0,3	2	1	100,0	11	3	86	100,0	16	1	83	100,0	0,29	0,89	0,00	214	205
Khingou	Obikhinghob	S4751	A.Resentini	120	28	1	10	----	1	19	4	5	----	14	1	2	3,6	0,6	3	9	100,0	32	12	56	100,0	26	2	72	100,0	0,44	0,91	0,00	215	171
Vakhsh	Chumdon	S4750	A.Resentini	170	32	2	9	1	1	10	4	6	----	12	5	3	5,3	----	1	8	100,0	36	12	52	100,0	36	8	55	100,0	0,30	0,84	0,06	216	168
Hari Rud	Gush Sargousi	S3463	G.Radeff	210	38	9	13	4	5	8	0,3	1	----	9	5	4	----	0,9	2	1	100,0	40	22	38	100,0	30	32	38	100,0	0,15	0,58	0,02	199	131
eolian dune	Ashk-Abad	S5335	A.Resentini	100	49	3	17	1	1	12	1	1	0,3	5	3	1	1,7	----	0,3	6	100,0	52	21	27	100,0	26	10	64	100,0	0,21	0,85	0,06	200	175
eolian dune	Orfa	S419	G.Radeff	360	29	9	6	2	2	37	0,4	8	1	3	3	1	0,2	----	----	----	100,0	29	15	56	100,0	7	8	85	100,0	0,07	0,39	0,02	187	62
eolian dune	Tuar	S418	G.Radeff	350	48	12	9	4	3	4	----	4	2	3	9	2	----	----	----	----	100,0	48	21	31	100,0	26	38	37	100,0	0,18	0,44	0,06	149	75

Tab A2 - Sand petrography. GSZ = grain size. Q = quartz (Qp = polycrystalline); F = feldspars (KF = K-feldspar; P = plagioclase; Mic = cross-hatched microcline); L = aphanitic lithic grains (Lv = volcanic and subvolcanic; Lvf = felsic volcanic and subvolcanic; Lvm = mafic and intermediate volcanic and subvolcanic; Ls = sedimentary; Lcc = limestone; Lcd = dolostone; Lp = shale/siltstone; Lh = chert; Lm = metamorphic; Lms = low-rank metasedimentary; Lmv = low-rank metavolcanic; Lmf = high-rank metapelite/metapsammite/metafelsite; Lmb = high-rank metabasite; Lu= ultramafic). HM= heavy minerals. The metamorphic indices MI and MI* express the average metamorphic rank of rock fragments in each sample. MI varies from 0 (detritus shed by exclusively sedimentary and volcanic cover rocks) to 500 (very-high-rank detritus shed by exclusively high-grade basement rocks). MI* considers only metamorphic rock fragments, and thus varies from 100 (very-low-rank detritus shed by exclusively very low-grade metamorphic rocks) to 500 (Garzanti & Vezzoli 2003).

River	Site	Sample	Operator	class analysed	%finer	%class	%coarser	method	tHM counted	total grains	HM %weight	tHM %weight	zircon	tourmaline	rutile	titanite	apatite	epidote	garnet	chloritoid	staurolite	andalusite	kyanite	sillimanite	amphibole	clinopyroxene	hypersthene	spinel	axinite	barite	Total
Syr Darya levee	Buramatutu	S4632	M.Limonta	15-500	60%	36%	4%	Point	207	332	1,5	1,5	5	2	----	4	9	26	11	----	1	----	----	0,5	41	1	----	----	----	----	100,0
Panj	Kishti Poyen	S4748	M.Limonta	32-500	6%	94%	----	Point	211	325	6,3	5,9	1	1	----	0,5	3	43	6	----	2	0,5	0,5	2	36	5	----	----	----	----	100,0
Yakhsu	Dara-Khurdak	S4749	M.Limonta	32-500	8%	76%	16%	Point	211	548	1,2	1,2	1	6	2	----	5	44	21	0,5	0,5	----	----	0,5	20	----	----	----	----	----	100,0
Khingou	Obikhinghob	S4751	M.Limonta	32-500	8%	92%	0,02%	Point	206	290	6,2	6,2	1	1	----	----	1	69	6	----	3	----	0,5	0,5	16	1	----	----	----	----	100,0
Vakhsh	Chumdon	S4750	M.Limonta	32-500	4%	96%	0,04%	Point	202	238	9,2	9,1	----	----	0,5	----	0,5	71	8	----	----	----	----	----	20	----	----	----	----	----	100,0
Hari Rud	Gush Sargousi	S3463	M.Limonta	32-500	6%	94%	----	Point	235	421	2,9	2,3	5	3	2	1	4	28	9	----	1	0,4	----	1	26	17	1	1	----	1,3	100,0
eolian dune	Ashk-Abad	S5335	M.Limonta	32-500	----	100%	----	Point	207	243	4,7	4,6	3	0,5	0,5	0,5	2	54	10	----	1	----	----	----	25	3	----	----	0,5	----	100,0
eolian dune	Orfa	S419	M.Limonta	32-500	2%	98%	----	Point	211	302	2,3	1,9	5	1	0,5	0,5	1	43	11	----	----	----	0,5	1	31	4	1	----	----	----	100,0
eolian dune	Tuar	S418	M.Limonta	bulk	----	100%	----	Fleet	207	1196	1,6	0,5	13	2	1	----	3	44	18	----	0,5	----	----	----	14	5	----	----	----	----	100,0

River	Site	Sample	Operator	HCI	MMI	ZTR	% transparent HM	% opaque HM	% Fe oxides	% Ti oxides	% turbid HM	% rock fragments	% soils & alterites	% chlorite	% biotite	% carbonates	& light minerals	Total
Syr Darya levee	Buramatutu	S4632	M.Limonta	17	n.d.	7	62%	1%	0%	0%	0%	1%	25%	2%	6%	1%	0%	100%
Panj	Kishti Poyen	S4748	M.Limonta	21	67	2	65%	2%	3%	0%	0%	2%	16%	3%	7%	1%	0%	100%
Yakhsu	Dara-Khurdak	S4749	M.Limonta	7	n.d.	9	39%	1%	0%	0%	0%	5%	34%	11%	7%	2%	0%	100%
Khingou	Obikhinghob	S4751	M.Limonta	16	44	2	71%	0%	0%	0%	0%	2%	15%	2%	7%	1%	0%	100%
Vakhsh	Chumdon	S4750	M.Limonta	19	n.d.	0	85%	0%	0%	0%	0%	2%	11%	0%	1%	0%	0%	100%
Hari Rud	Gush Sargousi	S3463	M.Limonta	19	67	10	56%	6%	6%	3%	0%	1%	22%	3%	2%	1%	0%	100%
eolian dune	Ashk-Abad	S5335	M.Limonta	26	n.d.	4	85%	0%	1%	0%	0%	0%	12%	0%	2%	0%	0%	100%
eolian dune	Orfa	S419	M.Limonta	20	n.d.	6	70%	4%	10%	1%	0%	1%	13%	0%	1%	0%	0%	100%
eolian dune	Tuar	S418	M.Limonta	19	n.d.	15	17%	8%	28%	3%	0%	0%	42%	0%	0%	2%	0%	100%

Table A3 - Heavy minerals. HM= heavy minerals; tHM= transparent heavy minerals; n.d. = not determined. The ZTR index (sum of zircon, tourmaline and rutile over total transparent heavy minerals) evaluates the "chemical durability" of the detrital assemblage (Hubert 1962; Garzanti 2017). The HCI (Hornblende Colour Index) and MMI (Metasedimentary Minerals Index) vary from 0 in detritus from greenschist-facies to lowermost amphibolite-facies rocks yielding exclusively blue/green amphibole and chloritoid, to 100 in detritus from granulite-facies rocks yielding exclusively brown hornblende and sillimanite, and are used to estimate the average metamorphic grade of metaigneous and metasedimentary source rocks, respectively (Andò et al. 2014).