

Installation & Recovery of Monazite, Xenotime and Rare earth bearing Minerals in riverine placers of Siri River Areas, Jashpur District Chhattisgarh.

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Abstract:

Rare metals like Nb, Ta, Li, Be, Cs and REE from La to Lu, besides Scand Y find diverse applications in various sectors of industries such as electronics, manufacture, medical science, technology, renewable energy, agriculture besides nuclear energy. In view of their wide utility, their extraction and recovery from their minerals in riverine placers assume global importance. The extraction from Siri River area and tributaries in Jashpur district Chhattisgarh was carried out under AMD exploration and extraction program. A plant with requisite machinery and equipment was installed for the purpose and an adequate flow sheet was designed. Details of the installation of Plant, recovery of mineral concentrates, their up gradation and various other facets have been discussed in the paper.

Rare Metal and Rare Earth Investigation

Form the last five to six decades RMRE investigation group carrying out investigations for the resources of metals and important minerals.

The Niobium (Nb), Tantalum (Ta), Lithium (Li), Beryllium (Be), Cesium (Cs) includes in Rare Metals and Lanthanum (La) to Lutetium (Lu) besides Scandium (Sc) and Yttrium (Y).are includes in Rare Earths: (REE).

Objective:

Xenotime bearing placers exist around Kunkuri area in Siri River and tributaries of Champajharia nala and Baljora nala placers have been worked out for obtaining Xenotime, Monazite and REE Mineral concentrates.

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As the Global demand for rare earths have increased in recent years and increased more and more uses, the areas are taken for establishing recovery plant at River site.

Executive Summary:

Type of deposit and Important locales	Riverine Placers. Significant xenotime concentration is located in Siri River (28.5km length), Champajharia Nala (6.5 km length) and Baljora Nala (10 km) in Ib River basin.
Toposheet No.	64 N/13 &14 and 73 B/1 & 2
Accessibility	Well-connected from Jharsuguda, Raigarh and Ranchi
Regional Geology	<p>Archaean meta sedimentary and meta basic rocks. The vast stretch of granitic rocks form the western part of the Chhota Nagpur Granite Gneiss Complex. With emplacement of a variety of younger granites (Middle Proterozoic), pegmatites, aplites and dolerites.</p> <p>Amongst the younger granites (1005 ± 12 Ma), three different types are identified.</p> <ul style="list-style-type: none"> i) Medium grained grey coloured two mica granite, ii) Fine grained biotite granite and iii) Coarse grained pink coloured two mica granite.
Mineralogy	Xenotime, Monazite, Ilmenite, Magnetite, Garnet, Zircon, Apatite etc.
Nature of heavy mineral deposition	Along River course in Island bars/Braid Bars, Side bars, Point Bars and Flood plains
Radioactivity	1.5 to 2 xbg in source granite/pegmatites. However, Placer bars record 5 to 20 xbg. Concentration of heavy minerals is found to increase with increase in radioactivity.
Grade of HMC	0.50 to 3.89% in placer bars considered for reserve estimation. The cut off being 0.50% HMC. However, lean grade (0.20 to 0.45% HMC) placer bars do also exist.

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Analytical Results	Source rock	Upto 53 ppm Y
	Raw Sand	0.06 to 0.08% Xenotime
	Concentrate	3 to 5 % Xenotime, 2 to 3.50% Y ₂ O ₃
	Upgraded Product	Xenotime rich: 18-22% Y ₂ O ₃
	(Magnetic Separation)	Monazite rich: 3-4.5% Y ₂ O ₃
Future Prospect	The available heavy minerals concentrate in placer bars of Siri River, Champajharia and Baljora Nala could sustain recovery operations for more than 10 years.	

Regional Geology:

The area around Kunkuri consists of Archaean meta sedimentary and meta basic rocks form the western part of the Chhotanagpur Granite Gneiss Complex (CGGC). Amongst the younger granites three different types are identified Medium grained grey colored two mica granite. Fine grained biotitic granite and coarse grained pink two mica granite.

REE Minerals:

0. Bastnaesite: Y Ce (CO₃)FOH

Fluro carbonates of Cerium Yttrium Carbonates Contain 60 %

REO Y₂O₃ 0.1 – 0.30

Hard rock deposit

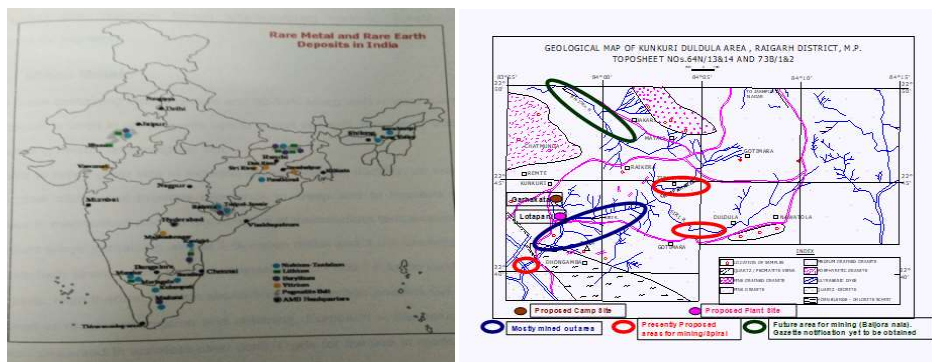
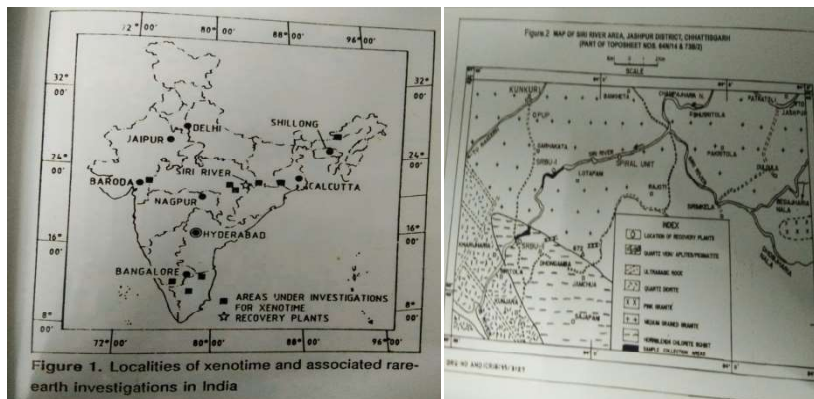
China Bayan OBO 2.73-42-75%

Mountain Pass 9.89- 13.18%

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1. Monazite: $(La\ Ce\ Y\ Th)\ PO_4$
A rare earth Phosphate concentration contain 55-60 % REO, 1-2 % Y_2O_3 & 8- 10 % ThO_2
2. Xenotime: YPO_4
A Phosphate of Yttrium concentrate contain 25% Y_2O_3 40 % REO 0.30 % U
3. Fergusonite : $Y\ (Nb, Ta)\ O_4$ Oxide
4. Fluocerite : $(Ce, La\ Y)\ F$

Location of Area:



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Placer Bars in Siri River



Placer Bars in Champajharia Nala



Placer Bars in Baljora Nala



Vertical Stratification in Placer Bar

Fig.2

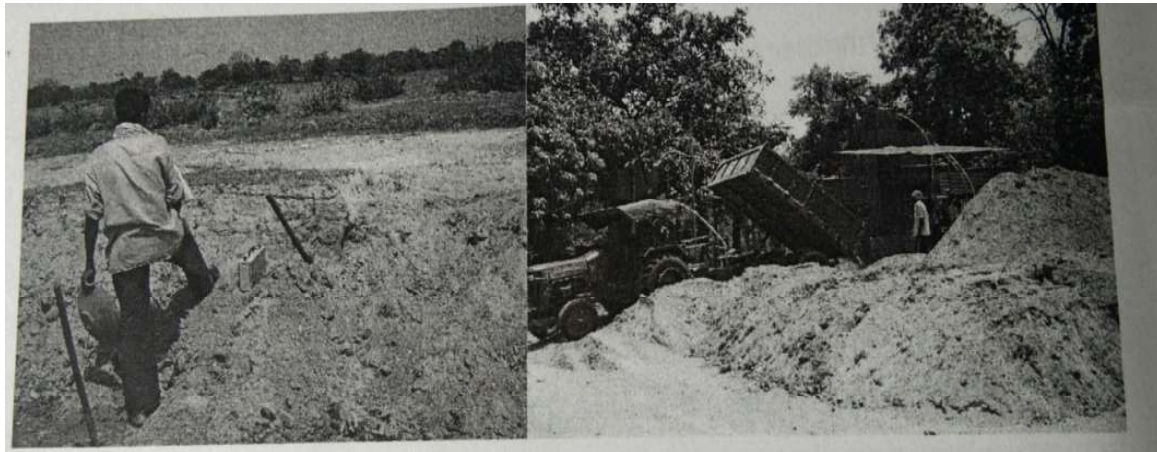


Checking of Radioactivity:

Mining, Excavation and Transportation of Raw sand:

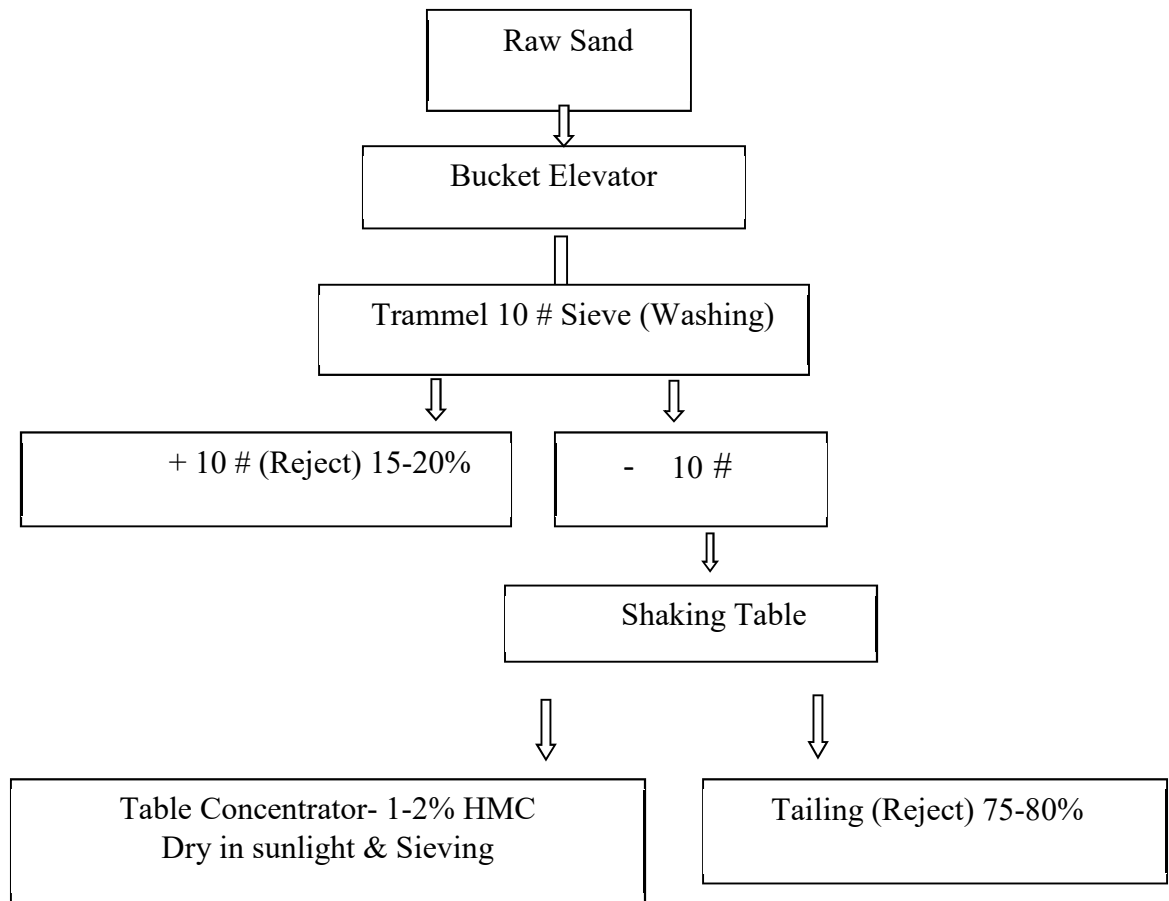


Transported Sand at Plant Site:



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Flow Sheet:



Treatment of Raw Sand and Siri River Unit

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Mineralogy:

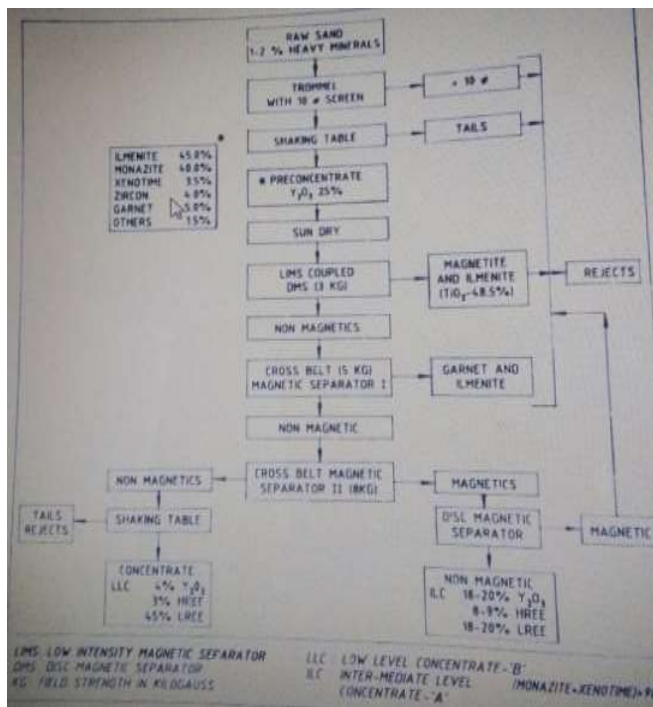
Heavy Mineral concentrates in Raw Sand and Poly Mineral Concentrates

Minerals	Raw Sand %	Minerals %
Magnetite	0.01- 0.50	1-5
Ilmenite	0.8 -1.0	40-45
Monazite	0.6- 0.8	35-40
Xenotime	0.06- 0.08	3-5
Garnet	0.01- 0.02	1-2
Apatite	0.02- 0.04	3-4
Amphibole & Rutile	4.01- 0.02	1-2

Total Heavies: 1-2%

The heavy mineral concentrate further up graded by using High Tension Magnetic separator and upgraded the Xenotime and Monazite products at Siri River.

Flow Sheet - High Tension Magnetic Separator:



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Complete Chemical Analysis of Poly Mineral Concentrate:

Elemental oxide	Value in %	Elemental oxide	Value in %
La ₂ O ₃	5.90	ThO ₂	3.85
Ce ₂ O ₃	10.95	Nb ₂ O ₅	0.40
Pr ₂ O ₃	1.10	Ta ₂ O ₅	<0.10
Nd ₂ O ₃	4.20	ZrO ₃	1.15
Sm ₂ O ₃	0.90	SiO ₂	10.60
Eu ₂ O ₃	0.033	TiO ₂	16.90
Gd ₂ O ₃	0.68	P ₂ O ₅	15.15
Tb ₂ O ₃	0.097	SnO ₂	<0.10
Dy ₂ O ₃	0.68	WO ₃	<0.10
HO ₂ O ₃	0.15	FeO (T)	16.00
Er ₂ O ₃	0.49	MnO	1.45
Tm ₂ O ₃	0.08	Al ₂ O ₃	1.00
Yb ₂ O ₃	0.48	CaO	0.82
Y ₂ O ₃	5.30	Na ₂ O	0.37
U ₃ O ₈	0.135	K ₂ O	0.24

Total REE- 31.11%

Total LREE- 23.08 (La to Eu)

Total HREE – 8.03 (Gd to Lu including Y)

Chemical Analysis of Xenotime & Monazite rich products:

Chemical analysis	Xenotime Conc. (9 kg, 7.50 Wt. % of HMC)	Monazite Conc. (14 Kg 39 Wt % of HMC)
Total REO including Y	52.61 - 53.48	53.73 - 54.26
LREE	1.82 - 2.59	47.87 - 49.80
HREE	14.80 - 15.24	2.15 - 2.51
Y ₂ O ₃	35.61 - 36.09	2.31 - 3.35

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ThO ₂	0.90-0.96	9.36-9.79
U ₃ O ₈	1.05 – 1.10	0.49 – 0.53
P ₂ O ₅	32.20 – 32.54	28.91- 29.88
SiO ₂	1.41 – 2.01	1.57- 2.04

Applications of Rare earth Elements:

REE are an interesting group of metals that are strategic materials in the world economy. Global demand is found for rare earth elements due to increased more uses. Rare earth elements (REEs) are key constituents of modern technology and play important roles in various chemical and industrial applications.

Industrial applications of REE:

Electronics: TV Screens, Computers, Cell phones, silicon chips, monitor displays, long life rechargeable batteries, camera lenses, LEDs, compact fluorescent lamps - CFLs, baggage scanners, marine propulsion systems

Manufacturing: High strength magnets, metal alloys, stress gauges, ceramic pigments, colorants in glassware, chemical oxidizing agents polishing powders, automotive catalytic convertors

MedicalScience: Portable X- ray machines, X- ray tubes, magnetic resonance imagery (MRI) contras agents, nuclear medicine imaging, cancer treatment applications, genetic screening tests, medical and dental lasers

Technology: Lasers, optical glass, fiber optics, radar detecting devises, nuclear fuel rods, mercury vapor lamps, highly reflective glass, computer memory, nuclear batteries, high temperature superconductors

Renewable Energy: Hybrid automobiles, wind turbines, bio fuel catalysts rechargeable batteries

Agriculture: Used as fertilizers and feed additives.

Nuclear Energy applications of REE:

Because of high thermal neutron cross section properties certain REE proved to be very useful in nuclear applications

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1. Yttrium Hydrides: Use of Hydrides as Hydrogen moderates and Yttrium oxide used as diluents in nuclear fuel.
2. Cerium: Cerium used as burnable fusion in reactor for control rods for stopping reactor in case of accident.

References:

1. Pusalkar K.N.and Bhatnagar G.S. AMD Annual Report, 1969.
2. Pusalkar K. N and Sahashrabudhe G.H, AMD Annual Report 1975.
3. Rai S. D., Shivananda, A.S. R., Tiwari K. N., Banerjee D.C. and Ravi Kaul, Xenotime bearing Inland Placers in India and their Beneficiations EARFAM Volume 4, 1991, Page 77-92.
4. RameshBabu, P.V. Rajendran R, Mundra K.L., Sinha R.P. & Banerjee D, C. Resources of Yttrium and REE Minerals in Riverine Placers of M. P and Bihar Recent Advance in Exploration & Research for REE,Kochin1995, Page,. 10-15.
5. Mundra K.L. and Dr. Shinde M. G., AMD Annual Reports, 2012-2016.

Bio-sketch of Dr. M G Shinde



Dr. M G Shinde, Superannuated from Atomic Minerals Directorate for Exploration and Research (AMD). He had expertise in XRF technique, besides expertise in Nb-Ta Recovery from mica belts (Bihar), exploration and extraction of monazite, xenotime and rare earths bearing minerals in riverine placers (Siri River areas, Jashpur distt. Chhattisgarh), Heap leaching of uranium recovery (in Kasha Kandi, Shimla distt. And Khiya, Andalada, Hamirpur distt. Himachal Pradesh etc.)