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Petrology and geochemistry of greywackes of the ~1.6 Ga Middle Aravalli Supergroup, northwest India: evidence for active margin processes

Nurul Absar[a]* and B. Sreenivas[b]

[a]*Department of Earth Sciences, Pondicherry University, Puducherry, India;* [b]*CSIR-National Geophysical Research Institute, Hyderabad, India*

(*Received 31 August 2014; accepted 14 December 2014*)

Geochemical and petrological studies of the well-preserved greywacke horizon of the 'Middle Aravalli Group' were carried out to constrain the early evolution of the Aravalli basin. Petrological and geochemical attributes of Middle Aravalli greywackes (MAGs) such as very poor sorting, high angularity of framework grains, presence of fresh plagioclase and K-feldspars, variable Chemical Index of Alteration (CIA) index (46.7–74.5, avg. 61), and high Index of Compositional Variability (ICV) value (~1.05) suggest rapid physical erosion accompanying an active tectonic regime. The sediments record post-depositional K-metasomatism and extraneous addition of 0–25% (avg. ~10%) K is indicated. Assuming close system behaviour of immobile elements during sedimentation, various diagnostic element ratios such as Th/Sc, La/Sc, Zr/Sc, and Co/Th, Eu anomaly and rare earth element patterns of MAG suggest that the Archaean Banded Gneissic Complex (BGC) basement was not the major source of sediments. In conjunction with the dominant 1.8–1.6 Ga detrital zircon age peaks of Middle Aravalli clastic rocks, these data rather indicate that the sediments were derived from a young differentiated continental margin-type arc of andesite–dacite–rhyodacite composition. A highly fractionated mid-oceanic-ridge-basalt-normalized trace element pattern of MAGs, with characteristic enrichment of large-ion lithophile elements (LILEs), depletion of heavy rare earth elements, negative Nb-Ta, Ti and P anomalies, positive Pb anomaly, and distinctive Nb/Ta, Zr/Sm, Th/Yb, and Ta/Yb, Ce/Pb ratios envelop the composition of modern continental arc magmas (andesite–dacite) of the Andes, suggesting a subduction zone tectonic setting for precursor magma. High magnitude of LILE enrichment and high Th/Yb ratios in these sediments indicate that thick continental crust (~70 km) underlay the 'Middle Aravalli' continental arc, similar to the Central Volcanic Zone of the modern Andes. We propose that eastward subduction of Delwara oceanic crust beneath the BGC continent led to the formation of a continental volcanic arc, which supplied detritus to the forearc basin situated to the west. This model also explains the opening of linear ensialic basins in the Bhilwara terrain, such as in Rajpura–Dariba and Rampura–Agucha in a classical back-arc extension regime, similar to the Andean continental margin of the Mesozoic. On the basis of the recent $^{207}Pb/^{206}Pb$ detrital zircon age of Middle Aravalli sediment, a time frame between 1772 and 1586 Ma can be assigned for Middle Aravalli continental arc magmatism.

Keywords: greywacke; Aravalli Supergroup; trace element geochemistry; continental arc; provenance; weathering; K-metasomatism

Introduction

The clastic sedimentary archive is one of the main sources of information regarding past geological conditions that prevailed on the Earth's surface. Such sediments preserve detritus from ancient orogens, which may get obscured later by tectonic overprinting or even eroded. In many cases, clastic rocks provide important clues to long-eroded or obscured source rocks (e.g. Saha *et al.* 2004; Chakrabarti *et al.* 2007; Guo *et al.* 2012; Wang *et al.* 2012). Clastic sedimentary rocks have also been used to understand orogenic progression, unroofing, tectonic setting of the provenance, and climatic conditions during the time of their deposition (Basu *et al.* 1990; Nie *et al.* 2012; references therein). The chemical record of clastic sedimentary rocks is considered to be influenced by source rock characteristics, chemical weathering, sorting processes during transport, sedimentation, and post-depositional diagenetic reactions (McLennan 1989; Nesbitt *et al.* 1996). However, certain relatively less mobile element pairs involving incompatible and compatible elements (such as Ti, Sc, Th, Zr, Hf, Cr, and Co), Rare Earth element (REE) patterns, and Nd isotope record of fine-grained clastic sedimentary rocks provide important clues regarding provenance and composition of upper continental crust (CC), and place important constraints on crustal extraction events and crustal growth models (e.g. Miller and O'Nions 1984; Taylor and McLennan 1985, 1995; Cullers 2000; Banner 2004; Saha *et al.* 2004; Condie 2005; Chakrabarti *et al.* 2007; Yang *et al.* 2012). Some aspects of the nature and intensity of chemical weathering, interaction between lithosphere–atmosphere–hydrosphere, can be estimated and inferred from the behaviour of different labile elements, such as alkalis and alkaline earth elements of clastic sedimentary rocks, by utilizing their analogous behaviour in modern weathering

*Corresponding author. Email: na_alig@yahoo.com

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Chapter No.: 13 | Date: 20-4-2018 | Time: 7:21 am | Page: 1/30

Trace, Rare-Earth Elements and C, O Isotope Systematics of Carbonate Rocks of Proterozoic Bhima Group, Eastern Dharwar Craton, India: Implications for the Source of Dissolved Components, Redox Condition and Biogeochemical Cycling of Mesoproterozoic Ocean

Nurul Absar, Mohd Qaim Raza, Sminto Augustine, Shreyas Managave, D. Srinivasa Sarma and S. Balakrishnan

Abstract The Bhima basin is one of a series of Proterozoic basins that overlie the Archean Dharwar craton of South India. In the present study, we have systematically sampled the carbonate rocks from three stratigraphic horizons of Bhima Group and conducted geochemical and C–O isotopic studies in order to understand the source of dissolved components, redox condition and biogeochemical cycling of Mesoproterozoic Ocean. The presence of original microbial texture and Proterozoic marine like $\delta^{18}O$ values (−6.38 to −7.17‰) indicate minimum diagenetic alteration. The carbonates have coherent REE + Y patterns and share the essential shale-normalised characteristics of well oxygenated, shallow ambient seawater, such as, (1) uniform heavy REE enrichment (Nd/Yb_{SN} = 0.43 ± 0.06), (2) consistent negative Ce anomalies (Ce/Ce* = 0.60 ± 0.05) and (3) superchondritic Y/Ho ratios (38.07 ± 3.17). The detailed geochemical modeling suggests (1) little influence (<1%) of clastic material on REY systematics, (2) significant contribution (∼>10%) of river/estuarine run-off to the ambient sea water and possibly minor input from oceanic hydrothermal sources. High positive values of $\delta^{13}C$ (3.8‰) in the basal Shahabad carbonates indicate burial of a large mass-fraction of isotopically light organic carbon. The gradual up-section decrease to ∼1‰ $\delta^{13}C$ suggest transgression and mixing of isotopically heavy coastal water (∼4‰) with global Dissolved Inorganic Carbon (DIC) reservoir (∼0‰). The short term negative $\delta^{13}C$ excursion of magnitude ∼5‰ at the base is consistent with upwelling of Oxygen Minimum Zone during the transgression event. The wide variability of $\delta^{13}C$

N. Absar (✉) · M. Q. Raza · S. Augustine · S. Managave · S. Balakrishnan
Department of Earth Sciences, Pondicherry University, Puducherry 605014, India
e-mail: na_alig@yahoo.com

D. Srinivasa Sarma
CSIR-National Geophysical Research Institute, Hyderabad 500606, India

M. E. A. Mondal (ed.), *Geological Evolution of the Precambrian Indian Shield*,
Society of Earth Scientists Series, https://doi.org/10.1007/978-3-319-89698-4_13

Exploration and Research for Atomic Minerals
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PETROGRAPHY AND MINERAL CHEMISTRY OF U-Th MINERALIZED LITHOUNITS OF THE GWALIOR BASIN, GWALIOR DIST., M.P. WITH A SPECIAL EMPHASIS ON HYDROTHERMAL ALTERATION AND REMOBILISATION

Minati Roy[1], Nurul Absar[2], A.K. Roy[3], S.D. Rai[1], Vivek Bist[4], C.L. Bhairam[4*] and P.S. Parihar[1]

Atomic Minerals Directorate for Exploration and Research, Department of Atomic Energy

[1] Hyderabad, [2]Nagpur, [4]New Delhi

[2]Department of Earth Science, Pondicherry University, Puducherry

[3]6-201, Divyashakti Apartments, Ameerpet, Hyderabad.

*Since Retired

ABSTRACT

Significant radioactivity has been recorded in the basement Bundelkhand granite and overlying Gwalior-Vindhyan Supergroup of sediments. The hydrothermal alterations viz. sericitisation, clay infiltration (argillic and intermediate argillic type), silicification, chloritisation, feldspathisation, formation of sulphide and uranium minerals and ferruginisation are quite significant along the brecciated and fractured zones of these rocks at the close proximity to the unconformity. Hydrothermally remobilized epigenetic uranium mineralization is confined to these altered zones as well as the unconformity contacts between underlying Bundelkhand granite-Gwalior Group (Par Formation), within Gwalior Group (Par and Morar Formations) and Gwalior Group-Vindhyan Supergroup (Kaimur Group). Uraniferous host rocks are granite and different cover sediments viz. quartz arenite, banded hematite quartzite and fine quartz arenite-siltstone with primary uranium minerals like coffinite, brannerite, U-Ti complex and adsorbed uranium associated with carbonaceous matter, clay and limonite. The ultimate source of U in the Gwalior basin appears to be the primary magmatogenic uranium minerals like gummite, metamict REE mineral, allanite, zircon and monazite in the underlying Bundelkhand granite which on repeated remobilization by deformation coupled with hydrothermal activity have given rise to epigenetic uranium mineralisation in the basement granitoids as well as in overlying cover sediments. The epigenetic U mineralisation is manifested as coffinite, brannerite, pitchblende, U-Ti complex, secondary U minerals (uranophane, kasolite, autunite) confined to weak planes and adsorbed U with later formed clay and limonite. Mineral chemistry of these mineral phases also corroborates the remobilisation and metasomatic exchanges which are indicated by low total, variable concentration of Zr, Si, U, Th and REE in zircon, high concentration of Zr, Y, P in coffinite and high value of Th in kasolite.

Keywords: Bundelkhand granite, Gwalior and Kaimur Group, Magmatogenic U and Th mineralisation, Hydrothermal remobilization.

Subject:	samples
From:	Sikta Patnaik (siktapatnaikamd@gmail.com)
To:	na_alig@yahoo.com;
Date:	Sunday, 24 August 2014 10:15 AM

Sir,
I am sending the details of samples. I have converted O PDB to O SMOW. You please see is it correct? I also plotted taking C PDB vs O SMOW. It is not very scattered. I think it shows more than one fluid, which is true. Sir do you have full paper Zheng, 1990? If you have pl send me the soft copy. The Xerox you gave me in that only first four pages of the paper are there. For Zheng 1993, full paper is there.
You pl see the data and suggest if something more can be interpreted.

Regards,
Sikta

Attachments

- Isotope data.xls (27.00 KB)

Subject:	Re: BRNS ppt from K.Chakrabarti
From:	NURUL ABSAR (na_alig@yahoo.com)
To:	kalyan_chak2002@yahoo.com;
Date:	Tuesday, 25 November 2014 12:11 PM

Thanks

From,
Dr. Nurul Absar
Assistant Professor
Department of Earth Sciences
Pondicherry University
Puducherry
605014
INDIA
Mob: +919843315191

"Nothing begets good science as much as the
development of a good instrument" - Sir Humphrey Davy (1778-1829)

On Tuesday, 25 November 2014 9:15 AM, KALYAN CHAKRABARTI <kalyan_chak2002@yahoo.com> wrote:

Dear Dr. Nurul Absar,

Thank you very much for sending your suggestions and the ppt presentation you are going to present. Your suggestion for the point no.2 &3 in our objective has been noted. for point no.3, it was a mistake in sentence formation and has been modified accordingly. For point no.2, your suggestion was also incorporated with an addition of "source rock composition" . Technical apart, in your presentation, the budget showed a provision of total Rs. 90, 000/- for PC and Co-Pc's visit to PI's institute, which I suppose need not be taken into consideration, as the relevant TA/DA of PC and Co-PC is borne by AMD for their movements. Please check it from Shri Ramesh Kumar and modify the budget accordingly.
Rest is fine,
we will meet you tomorrow through video conference and later by person.
Regards,

-- Kalyan Chakrabarti. SO.G
Incharge, Bhima Basin investigations,
SR, AMD, Bengaluru.

On Monday, November 24, 2014 10:06 PM, NURUL ABSAR <na_alig@yahoo.com> wrote:

Thank you very much. Pl find enclosed my PPT file. I suggest some modification in the 2nd and 3rd point of the objective.
2nd point: Mineral chemistry can be used for geothermometry, age dating
3rd point: Fluid inclusion studies of transparent gangue minerals to understand the Physico-chemical condition of ore bearing fluid.

- **Identification and mode of occurrence of U-mineral phases and other associated minerals - Mineral paragenesis (*Optical and electron microscopic study)***
- **Mineral chemistry to constrain the composition of the ore bearing fluid and their source rock *(EPMA study){Pl. note that one can not infer composition of ore bearing fluid from Mineral Chemistry (fluid inclusion, stable isotope are much better tools for this), however qualitative geothermometry (Temp of the fluid) can be done from major element compositions of relevant minerals pair or trace element concentrations in some ore minerals.}***

➢····· **Fluid inclusion study transparent gangue mineral phases occurring in veins sympathetic to U mineralisation to constrain physico-chemical conditions of ore bearing fluid,**
Major, Trace elemental and REE study to identify the nature of alteration
➢····· **C-, O- and S-Isotope studies to understand the nature of fluid, alteration behaviour during ore precipitation**
➢····· **synthesis of these data to propose a genetic model of uranium metallogeny in Gogi area**

Regards.

From,
Dr. Nurul Absar
Assistant Professor
Department of Earth Sciences
Pondicherry University
Puducherry
605014
INDIA
Mob: +919843315191

"Nothing begets good science as much as the
development of a good instrument" - Sir Humphrey Davy (1778-1829)

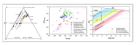
On Monday, 24 November 2014 3:34 PM, Amiya Pradhan <amiya.pradhan.amd@gmail.com> wrote:

Dear Sir
Please find the ppt of BRNS project.

Regards

Kalyan Chakrabarti

A K Pradhan



Journal of Asian Earth Sciences

Available online 6 June 2018

In Press, Accepted Manuscript — Note to users

Elemental and Sr-Nd isotopic geochemistry of Mesoproterozoic sedimentary successions from NE Lesser Himalaya, northern India: implications for Proterozoic climate and tectonics

Shaik A. Rashid[a], , Shamshad Ahmad[a], Sunil K. Singh[b], Nurul Absar[c]

[a] Department of Geology, Aligarh Muslim University, Aligarh-202001, India

[b] Geosciences Division, Physical Research Laboratory, Ahmedabad, India

[c] Department of Earth Sciences, Pondicherry University, Puducherry-605014, India

Received 28 September 2016, Revised 19 May 2018, Accepted 29 May 2018, Available online 6 June 2018

Show less

https://doi.org/10.1016/j.jseaes.2018.05.030

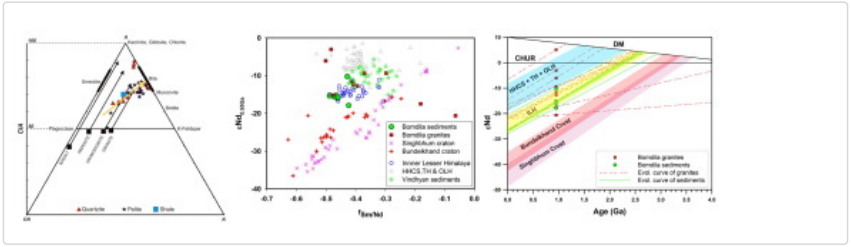
Highlights

- Mesoproterozoic sediments of NE-Himalaya were not derived from Peninsular cratons.
- Inner Lesser Himalayan terrain is likely source for Bomdila and Rupa Group of sediments.
- Warm and humid paleoclimatic conditions prevailed in the source region.
- Proterozoic sequences of NE-Himalaya were part of a long lived orogenic belt.

Abstract

The sedimentation history of northeastern Himalayan Proterozoic basins is poorly known . In the current study, we examine major, trace, rare earth elements (REEs) and Sr-Nd isotope geochemistry of pelites and quartzites from Mesoproterozoic metasedimenatary sequences of Bomdila and Rupa Groups, NE Himalaya in order to understand provenance, tectonic setting and paleoweathering conditions of deposition. The salient geochemical parameters, such as, high SiO_2 and Al_2O_3 concentrations, relatively low MgO values, typical enrichment of immobile incompatible elements (Al_2O_3/TiO_2=32.2, Th/Sc=2.1), fractionated REE patterns (La/Yb_n=28) and a strong negative europium anomaly (Eu/Eu∗= 0.3-0.7) indicate dominant felsic source for Bomdila sediments. Bomdila sediments show significantly radiogenic $\varepsilon Nd_{0.95Ga}$ values (-10.25 to -17.90, avg. -15.24) compared to Bundelkhand craton (avg. -26) and Singhbhum craton (avg. -30) and yield much younger T_{DM} ages (2.3-2.7Ga) compared to Archean Bundelkhand (3.2-3.5 Ga) and Singhbhum cratons (3.4-3.9 Ga) (Fig b). These results clearly rule out any significant detritus contribution from old cratonic sources. εNd and T_{DM} data of Mesoprterozoic Bomdila sediments envelop the signature of Lower Proterozoic Inner Lesser Himalayan (ILH) terrane. Prominent U-Pb age peaks at 1702, 1651, ~1400, 1248 and 1118 Ma in detrital zircons indicate major contribution from Late Paleoroterozoic to Late Mesoproterozic sources. However, initial Nd isotope ratios and T_{DM} do not favour any juvenile inputs. We argue that ILH source terrain may have been extensively reworked during Late Paleoroterozoic to Late Mesoproterozic time and could have been part of a long lived orogenic belt.. Severe depletion of Ca, Na and Sr in Bomdila sediments indicate intense chemical weathering of the source region, and can be attributed to warm and humid climatic conditions, a conclusion which is consistent with the CO_2-rich atmosphere during Mesoproterozoic period.

Graphical abstract



Keywords

Geochemistry; Nd-Sr Isotopes; Weathering; Provenance; Mesoproterozoic; NE Lesser I Himalaya

Corresponding author.

ISAG MEDAL WINNERS (2016)

Journal of Applied Geochemistry
Vol. 19, No. 3 (2017). pp. 365

Dr. Nurul Absar

Prof. J.S.R. Krishna Rao - Dr. R. Dhana Raju Medal

Dr. Nurul Absar presently working as Assistant Professor in the Department of Earth Sciences, Pondicherry University, Puducherry, India. He did his B.Sc (1994), M.Sc (1996) degree in Geology from Department of Geology, Aligarh Muslim University and was awarded University medal for securing 1st position in M.Sc examination. He worked on sedimentology, geochemistry and Nd-Sr-Pb isotope systematic of Proterozoic cover rocks of Bundelkhand Craton (Gwalior-Vindhyan basin) on a broad theme of 'crustal and hydrosphere evolution at Archean-Proterozoic boundary', in collaboration with Geochemistry Laboratory, NGRI and Geochronology Laboratory, AMD-Hyderabad under the supervision of Dr. S.M. Naqvi, Prof. M. Raza and Dr. Minati Roy. The results has been used for Ph.D degree in Geology by Aligarh Muslim University in 2006. The areas of research include Precambrian Geology and uranium metallogenesis.

He has 18 years of research experience he has worked as Scientific Officer in Atomic Minerals Directorate for Exploration and Research (AMD), Dept of Atomic Energy. During my tenure at AMD, I worked on uranium exploration in varied geological terrains (1) Proterozoic cover rocks of Bundelkhand craton (Gwalior and Vindyan Group) for Protoerozoic unconformity type U mineralisaton, (2) Tertiary foreland basins of Himalaya (Dharamshala and Siwalik Group) for sandstone type U mineralization and (3) Cambrian Lesser Himalaya (Krol & Tal Group) for black shale and phosphorite type U mineralization.

His key research contribution include (1) characterization of provenance and tectonic evolutionary model of Proterozoic basins of Bundelkhand and Aravalli craton, (2) direct Pb-Pb dating of chemical sediments of Paleoproterozoic Gwalior basin and (3) deduction of detailed metallogenetic and tectonic model of formation of strata-bound uranium deposit of Lower Cuddapah Group.

Till date he published several research papers in reputed international journals like Precambrian Research, Lithos, International Geology Review etc.; guided several students for M.Sc (Geology) and M.Tech (Exploration Geoscience) dissertation and currently three students are working for Ph.D under my supervision. He is a fellow and life member of many learned bodies, such as Geological Society of India, Indian Society of Applied Geochemists, Indian Association of Sedimentologists, and The Society of Earth Scientists. He has served as reviewer for several reputed international journals such as, Precambrian Research, Journal of Geology, Journal of Asian Earth Science, Geosciences Journal, Turkish Journal of Earth Science and Journal of Earth System Science.

Currently he is involved in studying Precambrian crustal and atmospheric evolution, using geochemistry and radiogenic stable isotope systematic of Proterozoic sediments of Eastern Dharwar craton as tools, and also working on uranium metallogeny of Eastern Dharwar craton.

INDIAN SOCIETY OF APPLIED GEOCHEMISTS (ISAG)

(Regd. No.3614)
Flat No. 102, "Surya Chandra Castle", Raghavendra Nagar,
Near Shanti Gardens, Nacharam, Hyderabad – 500 076, India
P.B. No.: 706, Osmania University
E-mail: isag1993@yahoo.co.in, ksprao1939@yahoo.co.in
Telefax: 040-29804411

To

Dr. Nurul Absar,
Assistant Professor,
Department of Earth Sciences,
Pondicherry University,
Puducherry-605014,
India.

No.ISAG/AGM/SMR/II/16/91 Date: 05-10-2016

Sub: ISAG - Prof. J.S.R. Krishna Rao - Dr. R. Dhana Raju medal for the best paper published in Journal of Applied Geochemistry (JAG), Vol. 18, 2016 - Award of medal and certificate - reg.

Dear Dr. Nurul Absar,

On behalf of Executive Council (EC) and own self I am pleased to inform you that your contribution on **"Petrography, clay mineralogy and geochemistry of clastic sediments of Proterozoic Bhima Group, Eastern Dharwar Craton, India: Implications for provenance and tectonic setting"** published in JAG Volume 18, Issue No.3, July 2016 has been adjudicated as the best article published in JAG for the year 2016. Please accept our congratulations for the achievement.

The medal and a merit certificate will be awarded to you at the Annual General Body Meeting (AGM-2016) of the ISAG scheduled during 9-11 November 2016, Department of Geology, Nagaland University, Kohima Campus Meriema, Kohima - 797004. . You are requested to receive the medal and certificate personally.

Further, the medal awardees have to do oral presentation of their work for 20 minutes (15 minutes + 5 minutes discussion) during the presentation ceremony and submit the material as an article to be published in Journal of Applied Geochemistry (JAG). The medal winner has to submit article compulsorily for publication in JAG.

Please provide passport size photo (B & W) and a brief **Bio-Data** and travel programme immediately.

Please confirm your participation.

Yours sincerely

(K. Surya Prakash Rao)
Convener/Hon. Secretary

Copy to: 1. B.M. Nizamudheen
2. Sminto Augustine

Government of India
Department of Atomic Energy (DAE)
Board of Research in Nuclear Sciences (BRNS)

Dr. Debanik Roy
Programme Officer (NRFCC)

BRNS Secretariat,1st Floor,
CC, BARC, Trombay,
Mumbai-400085Phone:
+91-2225593946
Fax: 2225593946
Email: deroy@barc.gov.in

No: 36(4)/14/50/2015-BRNS/36012 Date: 24/02/2016

OFFICE MEMORANDUM

Sub: **R/P entitled "Magmatic and hydrothermal processes of uranium mineralisation in Rasimalai alkaline complex, Tamil Nadu" under Prof. M.S. Pandian, Pondicherry University, Puducherry- 605 014 bearingsanction 36(4)/14/50/2015-BRNS with NRFCC, BRNS.**

On the recommendations of the Board of Research in Nuclear Sciences (BRNS), I am pleased to convey the administrative approval and sanction of the President of India for the captioned project for the 3 years beginning from financial year 2015-2016 with a total grant of Rs. 21,12,450/- (Rupees twenty one lakhs twelve thousand four hundred fifty only) for the project as under :

Item of expenditure	**Year 1 (2015-2016)**	**Year 2 (2016-2017)**	**Year 3 (2017-2018)**
Staff Salary - JRF	300000	300000	336000
Technical Assistance	50000	50000	50000
Consumables	100000	100000	100000
Travel - PI	100000	100000	100000
Contingencies	100000	100000	100000
Overheads	41250	41250	43950
Total(INR)	**691250**	**691250**	**729950**

Note: *
JRF salary calculated @25,000/- p.m. for first two years and on redesignation by committee on in third year as SRF @ 28,000/- p.m. RA salary calculated @ 36,000/- p.m.
Overheads calculated @ 7.5% of the other heads except contingency. The remaining 7.5% towards overheads (Rs. 1,26,450/-) shall be released only on meeting the requirements specified (See Annex-B).

2. I am also pleased to convey the sanction of the President of India to incur an expenditure of **Rs. 6,91,250/-** towards grant for the year 2015-2016 .
3. The expenditure involved is debitable to: **04 3401 00 004 08 0231**
4. This issues with the concurrence of Scientific Secretary, BRNS and IFA.

Debanik Roy
Dr. Debanik Roy

Pay & Accounts Officer,DAE, Mumbai-400 001.

Copy forwarded to:

1. Director of Audit, Scientific Department, AEAP, OYC, CSM Marg, Mumbai-400 001.
2. Joint Secretary (R&D), DAE, Anushakti Bhavan, CSM Marg, Mumbai-400 001.
3. Registrar, Pondicherry University, Puducherry- 605 014.
4. Principal Investigator(PI): Prof. M.S. Pandian, Pondicherry University, Puducherry- 605 014.

A. First year grant is being released in full along with this Sanction Letter through Pay & Accounts Officer, Department of Atomic Energy, Anushakti Bhavan, CSM Marg, Mumbai-400 001 directly. You may await a Money transfer (MT) through ECS and The amount would be credited electronically to A/C No: 413264160, A/C Name: Pondicherry University, IFSC: IDIB000P152, Indian Bank, Pondicherry University Branch, Kalapet, Puducherry-605014 .

i) Acceptance of this sanction and the MT for the amount sanctioned for the first financial year may please be acknowledged (Form-I).

ii) THIS SANCTION IS FURTHER SUBJECT TO THE CONDITIONS STIPULATED IN ANNEX (ENCLOSED), WHICH MAY BE GONE THROUGH CAREFULLY.

B. Second year Sanction Letter will be issued automatically in the month of April/May of the 2nd financial year, however, the grant will be released (unspent balance of previous year and Interest earned will be adjusted) after the PI submits the following documents to the Programme Officer NRFCC:

a) Claim in Form-II quoting the reference of the sanction issued for the first year.

b) Utilisation Certificate (UC) as on 31st March of the preceding financial year in Form-III duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant.

c) Statement of Accounts (SA) as on 31st March of the preceding financial year should be updated on the website. Interest earned in previous year should be reflected in the Statement of Accounts. A printout of the same should be sent to BRNS after it is duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant.

d) Copy of appointment order and joining report of the staff appointed for the project along with minutes of the Selection Committee, should be uploaded in a single pdf file under the file head “Staff Appointment Details”. In addition, the details of the appointed staff should also be updated in the available menu.

e) The inventory of equipment also should be updated in the menu, besides uploading the purchase order of the items costing more than 1 Lakh.

f) A One Page report on the progress of work during first year.

C. Third and subsequent years (if any) the Sanction Letter and the grant will be released on fulfillment of the following requirements:

i) Renewal/ Extension Application: Principal Investigator (PI) is required to upload by January 15 a pdf copy of duly signed renewal/ extension application in the prescribed form-(PRA) after logging into his/her account at www.daebrns.gov.in. All applications received shall be examined by experts from the field and PIs may be invited to a Technical Programme Discussion Meeting (TPDM). Renewal of the project will be based on the recommendations of the TPDM, Advisory Committee and the Board.

ii) Sanction Letter: If the progress is found to be satisfactory the renewal sanction for the year will be issued in the beginning of that financial year in April/May.

iii) Claim: On receipt of the renewal sanction, the PI shall claim the funds sanctioned by submitting the following documents to Programme Officer NRFCC, BRNS Secretariat, First FLoor, Central Complex, BARC, Trombay, Mumbai-400 085:

a) Claim in Form-II quoting reference of the renewal sanction.

b) Utilisation Certificate (UC) as on 31st March of the preceding financial year in Form-III duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant. should be reflected in the Statement of Accounts.

c) Statement of Accounts (SA) as on 31st March of the preceding financial year including the amount of Interest earned in previous year and duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant.

d) Copy of appointment order and joining report of the staff appointed for the project along with minutes of the Selection Committee.

e) An inventory of equipment and the copy of Purchase order of equipments costing more than 1 Lakh.

D. At the end of Terminal Year the Settlement Grant and the Balance 7.5% Overheads will be released on fulfillment of the following requirements:

a) Claim Form-II if any,

b) The final Consolidated Statement of Accounts and Consolidated Utilization Certificate duly audited by a Chartered Accountant or the Statutory (Govt.) Auditor.

c) Final Consolidated Progress Report and a brief report as per format given in Form-VII .

5. AAO (Bills II), DAE, Anushakti Bhavan, CSM Marg, Mumbai - 400 001 – With a request that the amount granted for the first year of the project may be released.
6. Member Secretary (NRFCC) : Dr. Vivekanand Kain, vivkain@barc.gov.in; Ph:+91-2225595067
7. Co-Investigator (CI) : Dr. Rajneesh Bhutani, Associate Professor, Department of Earth Sciences,, Email : rbhutani@gmail.com, Mobile :9443636422
8. Project Collaborator (PC): PC : Dr. M. Nagaraju, AMD, SR

9. Co PC: D. Bhattacharya, SO/G, BARC, Mumbai-85
10 Member Secretary, TSC-5, NRFCC : Shri K. Ramesh Kumar, Head, BSOI & MRG,AMD

You or your nominee may please be the DAE representative for selection of Research Fellow/ Research Associate for the project.

Debanik Roy

Dr. Debanik Roy

Note:

1. Please quote the Sanction Number 36(4)/14/50/2015-BRNS in all your correspondence with BRNS.
2. All the forms mentioned in the sanction letter and the terms & conditions are also available on the website. Kindly update Statement of Accounts, details of Equipment and staff in the menu available on the leftside when view application is clicked. The renewal/extension forms and scanned copy of duly signed financial documents (SA,UC & claim) also needs to be uploaded to get grant for subsequent years. Kindly verify that the data given in yourprofile is correct.

Government of India
Department of Atomic Energy
BRNS Secretariat

Central Complex, 1st floor,
BARC, Mumbai 400 085

No. 2009/36/53-BRNS/1815 Date: 5/10/09

Office Memorandum

Sub: R/P entitled "Modelling of fluid processes in the unconformity type uranium mineralisation in Srisailam and Painad sub-basins of Cuddapah basin, Andhra Pradesh" under Dr. M.S. Pandian, Department of Earth Sciences, Pondicherry University, Puducherry 605 014

On the recommendations of the Board of Research in Nuclear Sciences (BRNS), I am directed to convey the administrative approval and sanction of the President of India for the captioned project for three years beginning from financial year 2009-10 with a total grant of Rs.19,52,550/- as detailed below:

	Item of expenditure	I year (2009-10)	II year (2010-11)	III year (2011-12)
#	Staff : JRF (2)	2,88,000	2,88,000	3,36,000
$	Technical Assistance	25,000	25,000	25,000
	Consumables	50,000	50,000	50,000
	Travel : PI	1,00,000	1,00,000	1,00,000
	Contingency	1,00,000	1,00,000	1,00,000
&	Overheads	34,725	34,725	38,325
		5,97,725	5,97,725	6,49,325

JRF fellowship calculated @ Rs.12,000/- per month for first two years and @ Rs.14,000/- per month for third year **(revised)**.

$ Technical Assistance includes equipment hire charges, computer charges and charges for hiring services

& Overheads calculated @ 7.5% of other heads **except** contingency. The remaining 7.5% towards overheads (Rs.1,07,775) shall be released only on meeting the requirements specified (***see* Annex-B**).

2. I am also directed to convey the sanction of the President of India to incur an expenditure of Rs.5,97,725/- towards grant for the year 2009-10.

3. The expenditure involved is debitable to :

Grant No.	:	05	- Atomic Energy
Major Head	:	3401	- Atomic Energy Research
Minor Head	:	00 004	- Research & Development
Sub head	:	08 02	- BRNS
Detailed Head	:	08 02 31	- Grant-in-Aid

4. This issues with the concurrence of Scientific Secretary, BRNS and IFA.

Sd

(Dr. Debanik Roy)
Programme Officer, BRNS

Pay and Accounts Officer
Department of Atomic Energy
CSM Marg
Mumbai 400 001

No.2009/36/53-BRNS/ 1815 Date: 5/10/09

Copy forwarded to:

1. Director of Audit, Scientific Department, AEAP, OYC, CSM Marg, Mumbai - 400 001.
2. Joint Secretary (R&D), DAE, Anushakti Bhavan, CSM Marg, Mumbai-400 001.
3. Registrar, Pondicherry University, Puducherry 605 014
4. ** Principal Investigator : Dr. M.S. Pandian, Department of Earth Sciences, Pondicherry University, Puducherry 605 014

A. First year grant is being released in full through Pay & Accounts Officer, Department of Atomic Energy, Anushakti Bhavan, CSM Marg, Mumbai-400 001 directly. You may await a DD/ MT, accordingly.

i) **Receipt of this sanction letter and the DD/ MT for the amount sanctioned for the first financial year may please be acknowledged** (Form-I).

ii) THIS SANCTION IS FURTHER SUBJECT TO THE CONDITIONS STIPULATED IN ANNEX-A, ANNEX-B AND ANNEX-C **(ENCLOSED)**, WHICH MAY BE GONE THROUGH CAREFULLY.

B. Second year grant will be released after the PI submits the following documents to the Programme Officer (NRFC):

a) Claim in Form-II **(enclosed)** quoting the reference of the sanction issued for the first year.

b) Utilisation Certificate (UC) as on **31st March** of the preceding financial year in Form-III **(enclosed)** duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant.

c) Statement of Accounts (SA) as on **31st March** of the preceding financial year in Form-IV **(enclosed)** duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant.

d) Copy of appointment order and joining report of the staff appointed for the project along with minutes of the Selection Committee.

e) An inventory of equipment in Form-V **(enclosed)**.

f) A One Page report on the progress of work during first year.

C. Grant for the third year and subsequent years (if any), will be released only after the Principal Investigator (PI) fulfills the following requirement:

i) The Department will issue a fresh sanction for the third and subsequent years after receiving the recommendations of the BRNS after scrutiny of the Renewal Application in Form 4R.

Hence, **10 copies** of renewal request in the **Form 4R (enclosed)** and **3 copies** of detailed Progress Report must reach to **Dr. Vivekanand Kain, (MS, NRFC), Materials Science Division, BARC, Trombay, Mumbai-400 085** and one copy of **Form 4R** to **Dr. Debanik Roy, Programme Officer (NRFC), BRNS Secretariat, First Floor, Central Complex, BARC, Trombay, Mumbai-400 085** on or before **30th November of the second or subsequent year of the project as the case may be**.

ii) If the progress is found to be satisfactory the renewal sanction for the year will be issued in the beginning of that financial year.

iii) On receipt of the renewal sanction, the PI shall claim the funds sanctioned by submitting the following documents to **Programme Officer (NRFC)**:

a) Claim in Form II **(enclosed)** quoting reference of the renewal sanction.

b) Utilisation Certificate (UC) as on **31st March** of the preceding financial year in Form-III **(enclosed)** duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant.

c) Statement of Accounts (SA) as on **31st March** of the preceding financial year in Form-IV **(enclosed)** duly audited by the Internal Auditor of the University/ Institution or a Chartered Accountant.

d) However, the final consolidated Statement of Accounts/ Utilization Certificate to be submitted at the end of the Terminal year shall be audited by a Chartered Accountant or the Statutory (Govt.) Auditor.

e) Copy of appointment order and joining report of the staff appointed for the project along with minutes of the Selection Committee.

f) An inventory of equipment in Form-V **(enclosed)**.

g) Final consolidated Progress Report for settling the Terminal Grant.

5. AAO (Bills II), DAE, Anushakti Bhavan, CSM Marg, Mumbai - 400 001 – With a request that the amount granted for the first year of the project may be released immediately.
6. Member Secretary, NRFC : Dr. Vivekanand Kain, Materials Science Division, BARC, Trombay, Mumbai-400 085.
7. Member Secretary, TSC-4, NRFC : Dr. R.M. Tripathi, EAD, BARC, Mumbai 400 085
8. Dr. P.V. Ramesh Babu, Regional Director (South Central Region), Atomic Minerals Directorate for Exploration and Research, Hyderabad 500 629
9. Principal Collaborator : Shri S.J. Chavan, Scientific Officer, Atomic Minerals Directorate for Exploration and Research, Hyderabad 500 629 - You or your nominee may please be the DAE representative for selection of Research Fellow / Research Associate for the project.
10. Co-Principal Collaborator (1) : Shri K.K. Parashar, Scientific Officer, Atomic Minerals Directorate for Exploration and Research, Hyderabad 500 629
11. Co-Principal Collaborator (2) : Dr.A.V. Jeyagopal, Scientific Officer, Atomic Minerals Directorate for Exploration and Research, Hyderabad 500 629
12. Co-investigator : Dr. Rajneesh Bhutani, Department of Earth Sciences, Pondicherry University, Puducherry 605 014
13. Sanction file.

(Dr. Debanik Roy)
Programme Officer, BRNS

** Note : Please quote the Sanction Number **(No.2009/36/53-BRNS)** in all your correspondence with BRNS.

भारत सरकार / Government of India
परमाणु ऊर्जा विभाग / Department of Atomic Energy
उद्योग एवं खनिज अनुभाग / **I&M Section**

अणुशक्ति भवन, /Anushakti Bhavan,
छ.शि.म. मार्ग, / C.S.M. Marg,
मुंबई/Mumbai - 400 001

Subject: Re-constitution of "Apex Exploration Research Advisory Committee (AERAC) at AMD Headquarter, Hyderabad.

****

Enclosed please find Office Order No.12/2(5)/2008-I&M(AMD)/15864 dated 29.11.2016 on the captioned subject.

2. In this connection, it is requested to arrange to distribute the above mentioned Office Order dated 29.11.2016 to the Members of Apex Exploration Research Advisory Committee.

Encl: as above

29/11/16

(टी.जी. रवीन्द्रन/ T.G. Raveendran)
अवर सचिव (उएवं ख)/ Under Secretary (I&M)

AMD(Shri R.G. Raghavan, CA & AO) Begumpet, Hyderabad-500 016.
DAE ID Note No. 12/2(5)/2008-I&M(AMD)/15580 November 29, 2016

भारत सरकार / Government of India
परमाणु ऊर्जा विभाग / Department of Atomic Energy
उद्योग एवं खनिज अनुभाग / I&M Section

अणुशक्ति भवन, /Anushakti Bhavan,
छ.शि.म. मार्ग,/ C.S.M. Marg,
मुंबई/Mumbai - 400 001

No.12/2(5)/2008- आईएण्डएम (एएमडी)I&M(AMD)/ 15864 **नवंबर** November 29 ,2016

कार्यालय ज्ञापन OFFICE MEMORANDUM

विषय : एएमडी मुख्यालय , हैदराबाद में "शीर्ष अन्वेषण अनुसंधान सलाहकार समिति (एईआरसी)" का पुनर्गठन

Subject : Re-constitution of "Apex Exploration Research Advisory Committee (AERAC) at AMD Headquarter, Hyderabad.

****

उक्त विषय पर इस विभाग के दि. 2.11.2016 के का.ज्ञा सं. 12/2(5)/2008-आईएण्डएम (एएमडी)/11846 के अधिक्रमण में, उक्त विषय पर विभाग के सक्षम प्राधिकारी ने एएमडी मुख्यालय , हैदराबाद में "शीर्ष अन्वेषण अनुसंधान सलाहकार समिति (एईआरसी)" को पुनर्गठित किया है । पुनर्गठित एईआरसी का संघटन **अनुलग्नक-I** में दिया गया है ।

In supersession of this Department's O.M. No.12/2(5)/2008-I&M(AMD)/11846 dated 02.11.2016 on the captioned subject, the Competent Authority in the Department has re-constituted the "Apex Exploration Research Advisory Committee" (AERAC) at AMD Headquarter, Hyderabad. The composition of re-constituted AERAC is given in ***Annexure-I***.

2. एईआरसी के कार्य और एईआरसी के गैर सरकारी सदस्यों तथा अन्य केंद्र सरकारी अधिकारियों के मानदेय/ यात्रा / दैनिक भत्तों की पात्रता इस विभाग के दि. 16.02.2005 के 12/2(5)/2004- आईएण्डएम(एएमडी)/ 1369 और दि. 12.04.2005 की अविटिसं.12/2(5)/2004-आईएण्डएम(एएमडी)/ 2966 के द्वारा यथानिर्धारित /स्पष्टीकृत के अनुसार होंगी ।

The functions of the AERAC and eligibility for honorarium, travelling/daily allowance of non-official members and other Central Govt. officers of the

...2/-

AERAC etc. will be as set out/clarified vide this Department's O.M.No.12/2(5)/2004-I&M(AMD)/1369 dated 16.02.2005 and ID Note No.12/2(5)/2004-I&M(AMD)/2906 dated 12.04.2005.

3. इसे सचिव ,पऊवि के अनुमोदन से जारी किया जाता है
This issues with the approval of Secretary, DAE.

29.11.16

(टी.जी. रवीन्द्रन/ T.G. Raveendran)
अवर सचिव (उएवं ख)/ Under Secretary (I&M)

पुनर्गठित एईआरएसी के अध्यक्ष, सह अध्यक्ष एवं सदस्य
Chairman, Co-Chairman and Members of the re-constituted AERAC

अनुलग्नकAnnexure-I

एएमडी मुख्यालय , हैदराबाद में शीर्ष अन्वेषण अनुसंधान सलाहकार समिति (एईआरएसी) का पुनर्गठन

Re-constitution of Apex Exploration Research Advisory Committee (AERAC) at AMD Headquarter, Hyderabad

क्र.सं. Sl.No.	Name & Designation नाम एवं पदनाम	Position स्थिति
1.	डॉ ए.के.सूरी पूर्व निदेशक,सामग्री वर्ग ,भापअकेंद्र Dr. A.K. Suri, Former Director, Materials Group, BARC.	अध्यक्षChairman
2.	निदेशक ,एएमडी Director, AMD	सह- अध्यक्षCo-Chairman
3.	अपर महा निदेशक (भूविज्ञान) Additional Director General, (Geology) जीएसआई, कोलकत्ताGSI, Kolkata	सदस्य Member (जी.एस.आइ के प्रतिनिधि) (Representative from GSI)
4.	श्री राजेन्द्र सिंह, अपर निदेशक (से.नि.) एएमडी Shri Rajendra Singh, Additional Director (Retd.), AMD	सदस्य Member (Eminent Geologist प्रतिष्ठित भूवैज्ञानिक)
5.	श्री एस.सी. वर्मा, क्षेत्रीय निदेशक (से.नि.)एएमडी Shri S.C. Verma, Regional Director (Retd.), AMD	सदस्य Member (Eminent Geologist प्रतिष्ठित भूवैज्ञानिक)
6.	डॉ. एम. एस. पंडियन Dr. M.S. Pandian, प्रोफेसर एवं अध्यक्ष, पृथ्वी विज्ञान विभाग, पांडिचेरी विश्वविद्यालय, पुडुचेरी Professor and Head, Department of Earth Sciences, Pondicherry University, Puducherry - 605014.	सदस्य Member (Eminent Academician प्रतिष्ठित शिक्षाविद)
7.	प्रो. शालिवाहन श्रीवास्तव Prof. Shalivahan Srivastava, अध्यक्ष, अनुप्रयुक्त भूभौतिकी विभाग आईएसएम, धनबाद Head, Department of Applied Geophysics, ISM, Dhanbad-826 004, झारखंड Jharkhand.	सदस्य Member (Eminent Geophysicist प्रतिष्ठित भूभौतिकीविद)
8.	अध्यक्ष एवं प्रबंध निदेशक यूसीआईएल Chairman and Managing Director, UCIL	सदस्य Member
9.	निदेशक, एनजीआरआई, हैदराबाद Director, NGRI, Hyderabad	सदस्य Member
10.	अपर निदेशक (प्रचालन-I), एएमडी Additional Director (Operations - I), AMD	सदस्य Member

...4/-

क्र.सं. Sl.No.	Name & Designation नाम एवं पदनाम	Position स्थिति
11.	अपर निदेशक (प्रचालन-II), एएमडी Additional Director (Operations - II), AMD	सदस्य Member
12.	अपर निदेशक (प्रचालन-III), एएमडी Additional Director (Operations - III), AMD	सदस्य Member
13.	अपर निदेशक (आरएंडडी), एएमडी Additional Director (R&D), AMD	सदस्य Member

29.11.16

(टी.जी. रवीन्द्रन/ T.G. Raveendran)
अवर सचिव (उएवं ख)/ Under Secretary (I&M)

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E : a.das@cii.in
W : www.cii.in

Anjan Das
Executive Director

July 10, 2013

Project Reference No: GITA/DST/TWN/P-45/2013

INDIA-TAIWAN PROGRAMME IN SCIENCE & TECHNOLOGY

Sub: Sanction of Joint Research Project entitled **"Fuzzy Clustering in Finding Subtypes of Cancers in Large Cancer Medical Database"** under Indo-Taiwan Joint Research Programme in Science & Technology.

****

On behalf of Department of Science & Technology (DST), Government of India, Confederation of Indian Industry (CII) is pleased to sanction joint research project proposal entitled *"Fuzzy Clustering in Finding Subtypes of Cancers in Large Cancer Medical Database"* under the Indo-Taiwan S&T Cooperation Programme, at a total cost of **Rs 31,63,800/- (Rs Thirty One Lacs Sixty Three Thousand Eight Hundred Only).** The duration of the project shall be 3 years from date of issue of this Project Sanction Letter.

1. The composition of the project team is as below:

Indian PI	**Taiwanese PI**
Prof Kannan Subbaiya Rammohan, Department of Mathematics Pondicherry University, Kalapet, Puducherry - 605 014	**Prof Tzung-Pei Hong** National University of Kaohsiung Kaoshiung 811, Taiwan
Other Indian Project Participant(s)	**Other Taiwanese Project Participant(s)**
-	**Prof Wang Leon S L,** National University of Kaohsiung Kaoshiung 811, Taiwan
-	**Prof Lin Wen-Yang,** National University of Kaohsiung Kaoshiung 811, Taiwan
-	**Prof Tseng Vincent,** National Cheng-Kung University, 701, Tainan City, Taiwan

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de Pondichéry

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Institute
of Pondicherry

The Finance Officer
Pondicherry University
R. Venkatraman Nagar, Kalapet,
Pondicherry – 605 014

Letter ref: 141201-6-I-SG

Dear Sir,

As stated in the contract between the French Institute of Pondicherry and Pondicherry University, towards the organisation of the Social Sciences Winter School from 7 to 13 December 2014, please find enclosed three cheques (Nos: 805412 dated 01/12/2014, 805413 dated 03/12/2014, 805414 dated 08/12/2014) for a total amount of **INR 375 000**.

Thanking you,

Eve HERMANN
Secretary general
French Institute of Pondicherry
Phone : (91-0413) 223 1611
Fax : (91-0413) 233 9534