International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Occurrence of Volcanic Ash in Sagileru River Valley, Cuddapah District, Southern India

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Abstract: ***The Meso-proterozoic Cuddapah basin has volcaniclast in the Vempalli and Tadipatri Formation of the Papagni sub basin. The quaternary ash beds are recorded along the number of river valleys located within the Cuddapah basin. In the Kadapa district the light several occurrences of tephra between Vamsadhara Valley in the north and the Sagileru Valley in the south. The source of the volcanic lasts of the Papagni sub-basin has been clearly identified but the source for quaternary ash beds of the Sagileru river basin is yet to be established clearly. The perusal of literature indicates the possible acidic composition of these beds. The REE pattern of these rocks is also aimed that may through light on the nature of the magma that has contributed to the formation of these beds.***

Keywords: Ash beds, Sagileru, REE, Quaternary ash bedsand Tephram,

1. Introduction

The term Tephra was introduced by Thorarinsson in 1954 to designate pyroclastic ejecta. It is now well entrenched in the geological literature as a substitute for the more popular term 'volcanic ash'. Tephra occurrences are widespread all over the world. Prior to its discovery from Andhra Pradesh**,** tephra occurrences are reported from Ganga, Son, Narmada and Vamsadhara River Valleys in different States of India **(**Acharyya and Basu 1993,Rachna Raj 2008). It was reported from Sagileru valley for the first time in the southern part of peninsular India (Singa Raju and Sivaji, 1991a) and several discoveries followed it from Vamsadhara in the north to the Sagileru in the south. An attempt is made here to document all the occurrences of tephra in Andhra Pradesh and characterise them.

2. Geological Setup

In the Quaternary sequence of Andhra Pradesh, tephra occurs as lenses and layers within fluvial deposits or directly rest over basement rocks. It stands out as a relatively resistant band than the enclosing fluvial sediments. The major part of the study area its cover shales (figure -1). The contact of the ash bed with underlying sediments is usually very sharp and distinct, whereas the upper contact is normally gradational or diffused. The ash is light and greyish, acquiring brownish tinge on oxidation. It is massive and devoid of sedimentary structures in general. At a few places, lamination, banding, contortion and slump structures are present. The thickness of the ash bed varies from 10 cm to 2 m in general. And thickest ash bed is recorded from Sagileru Valley where it is about 6 m thick (see figure no.2)

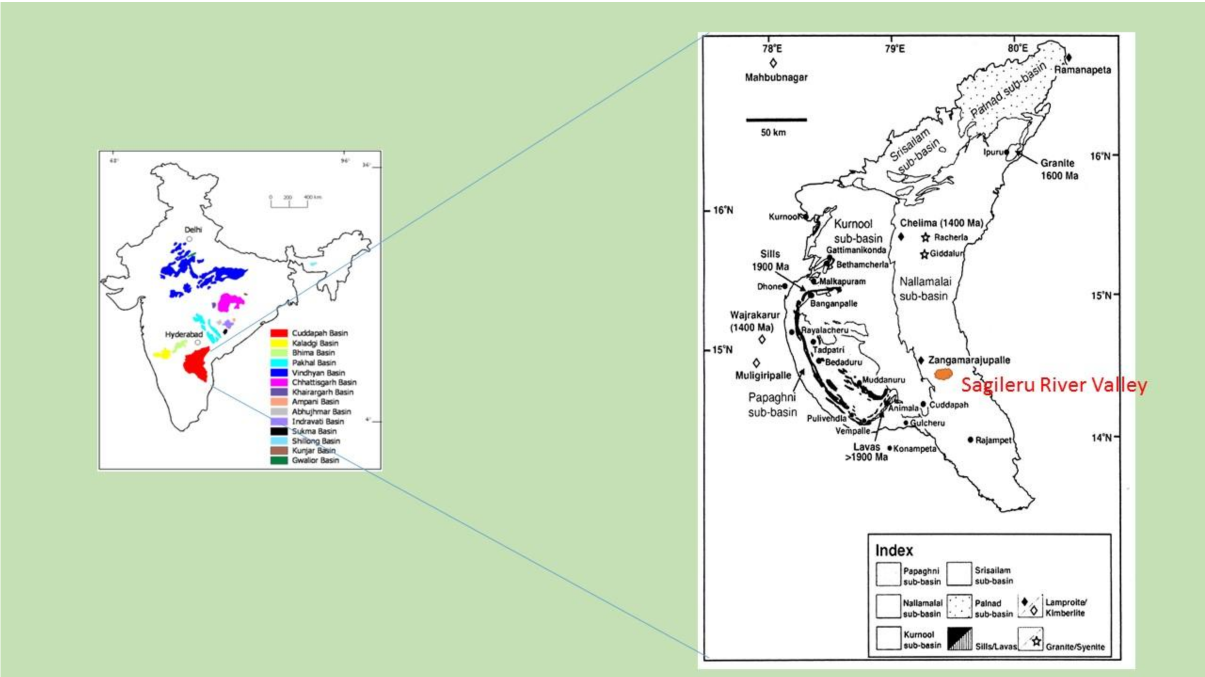

Figure 1: Location Map of in Sagileru River Vally

Figure 2A: Photographs showing the cliff section of ash bed in Sagileru River Vallyits about Less than 10cm width.

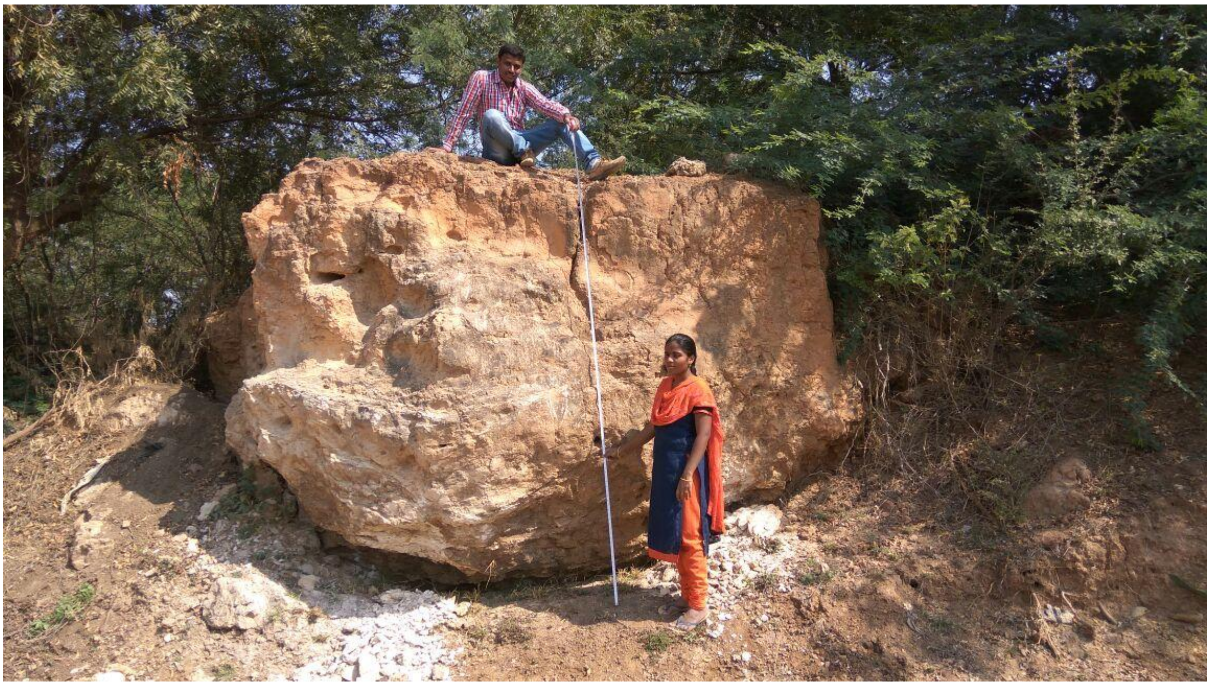

Figure 2B: Photographs showing ash bed in Sagileru River Vally its about More than 5m width

3. Geochemistry

Seven samples of volcanic ash from Sagileru river valleys were processed the bulk samples and glass shards separated from them were analysed for the major, minor oxides and Trace and REE, to study the chemical composition of the glass shards and that of the corresponding bulk sample. Details of chemical composition are given in Table-1. A comparision of the bulk composition of the ash and that of the constituent glass shards shows that SiO_2 is depleted and Al_2O_3, MgO, CaO are enriched in the former. The differences are mainly due to contamination of bulk sample with the detritals during transportation or deposition. However, the possibility of alteration also cannot be ruled out.

The Sagileru ash beds is found to be rich in silica (SiO_2 = 68.48%) and K_2O is low compared to SiO_2 (table 1). It shows a lower light REE (La, Ce, Pr, Nd, Sm) and higher heavy REE (Ho, Er, Tm, Yb, Lu) and in REE data show strong negative Euand Tm anomaly indicating progressive removal of plagioclase feldspar during fractional crystallization of the source magma larger Eu and Tm anomaly (table 1, figure 4). The analyses given in table 1 for other localities, for the purpose of comparison are actually calculated to 100% on a volatile free basis. The water content of ash beds of Indian occurrences given by Shane et al (1995) varies between 3.92 and 4.45% and in the samples of western continental margin by Pattan et al (2001) between 1.99 and 7.3%. Schulz et al (2002) reported LOI values forSagileru ash beds to be about 6%. The total of the analyses at Sagileru is 87% (table 1).The siliceous nature of the ash shows its unaltered state of preservation. The values also fall very close to the values of glass shards from various northern Indian Ocean sites (Schulz et al 2002). Slightly higher values for the oxide of iron could be due to the Fe_2O_3 value in Sagileru sample 2.61.A strong negative Euand Tm anomaly (figure 4) is also comparable with other continental Indian findings (Schulz et al 2002; Westgate et al 1998; Chesner and Ettlinger 1989; Pattan et al 2001 and Song et al 2000, Dhrama Rao 2012). The ash has been recognized as Sagileru ash beds by its lower light REE (La, Ce, Pr, Nd, Sm) content and higher heavy REE (Ho, Er, Tm, Yb, Lu) content and a larger Eu and Tm anomaly (table 1). The highly silicic nature of the ash of the Sagileru sample is very typical of the rhyolite (Fig 3A) and closely resembles and all the samples indicate alkaline affinity (fig 3B)

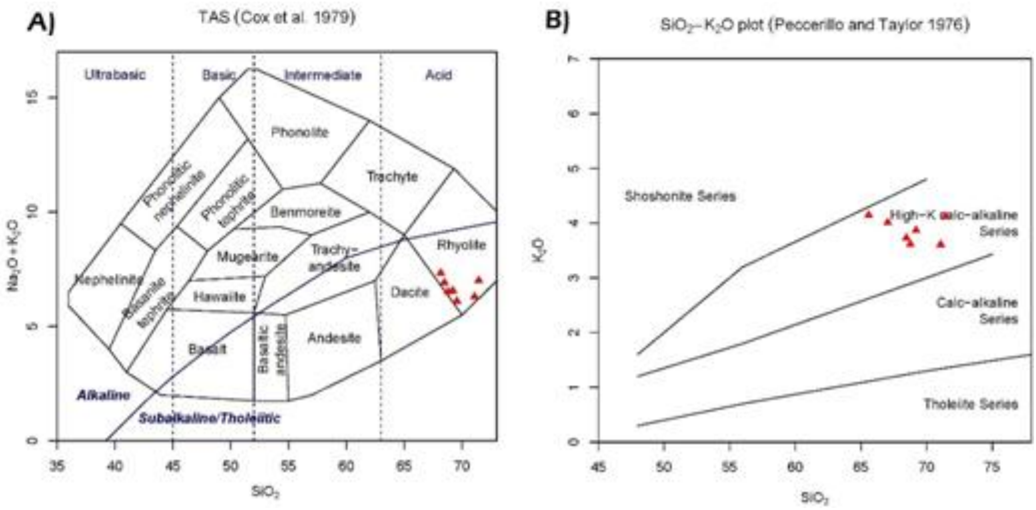

Figure 3: A) Geochemical discriminatory plots for the Sagileru ash beds, plots after (Cox et al 1979) B) SiO_2 vs K_2O (Peccerillo and Taylor 1976).

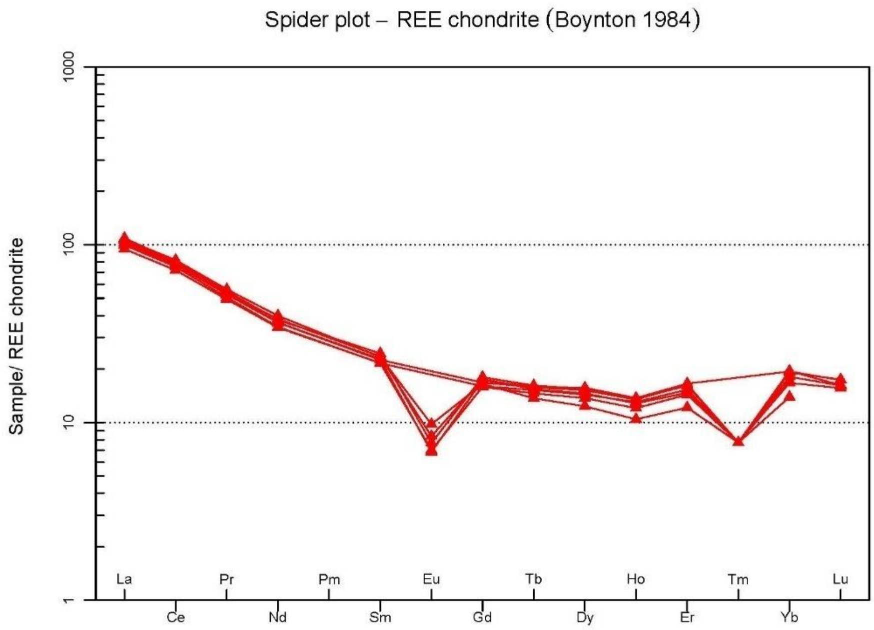

Figure 4: (A) Chondrite normalized (after MBaynton 1984) REE pattern of ash sample from the Sagileru ash beds showing strong negative Eu and Tm -anomaly, area enclosed within blue line indicates compositional range of the distal Sagileru river beds found in India

4. Discussion and Conclusion

The Sagileru volcanic event is one of the small eruptions during the Quaternary. This volcanic mega eruption (Rose and Chesner 1987, 1990; Knight et al 1986; Acharyya and Basu 1993) occurred in the Indonesian archipelago on northern Sumatra some 70,000 years ago during a major shift in global climatic conditions from interglacial marine isotopic stage (MIS) 5 to glacial MIS 4 (Ninkovich et al 1978). More than two orders of magnitude larger than any historical eruption, It is estimated that at least 1% of the Earth was covered by more than 3-4 m of ash known as Sagileru ash beds. The widespread tephra bed is reported from eastern and western parts of the Indian subcontinent (Acharyya and Basu 1993; Ninkovich et al 1978 and Chesner et al 1991) to the Arabian Sea (Schulz et al 1998), Indian Ocean (Pattan et al 1999) and also to the south China Sea (B¨uhring et al 2000 and Song et al 2000). The Sagileru event is believed to have a potential magnitude relevant to the global climate system (Singurdsson 1990) and has been held responsible for the shift to glacial climate (Chesner et al 1991; Rampino and Self 1992, 1993). However, evidence for a Sagileru triggered volcanic winter is ambiguous (Schulz et al 2002). According to Izett et al (1981) pumice shard develop from relatively highly viscous rhyolitic magmas with temperature <850◦C, whereas the bubble wall and bubble junction shards develop from lower viscosity rhyolitic magmas at temperature > 850◦C. The morphology suggests ash to be of Younger Sagileru ash beds of Indonesian origin. The geochemical data strongly suggest that the ash found in Sagileru River basin is associated with the Toba mega eruption of ∼ 74 ka. The Thermoluminescence (TL) dating of the lower part of the exposed sediment succession of this surface at Tilakwada, in the lower Narmada basin has yielded an age of < 90 ka (Chamyal et al 2002). This correlates very well with the ash found in almost the North part of the correlatable succession in the Sagileru River basin. The middle part of the sedimentary unit of Sagileru River points towards a low energy weak fluvial regime during the deposition of these sediments. The change in sediment characteristics from coarse to fine and from lower unit to middle unit also indicates towards the climatic fluctuations during this time. This is also supported by Kale et al (2004) in their studies on ash associated alluvial sediments of Deccan Trap region of India. The present finding of Sagileru ash beds at western continental margin further enlarges the estimated area and volume of fall out of Quaternary eruption. It requires further re-assessment of the volume of ash and its palaeoclimatic implications. Chronological studies of this ash bed in future could help establishing a precise time-controlled stratigraphy of the Quaternary sediments of Sagileru river valley.

Table:1 showing comparison of major oxides of Sagileru river

Sample no	S2	S3	S4	S6	S8	S9	S11		Sample no	S2	S3	S4	S6	S8	S9	S11
SiO2	68.77	71.08	71.44	67.05	68.47	69.20	63.33		**Y**	33	32	34	30	34	31	25
TiO2	0.16	0.14	0.11	0.20	0.14	0.25	0.44		**Nb**	15	16	16	14	15	15	14
Al2O3	0.16	0.14	0.11	0.20	0.14	0.25	0.44		**Mo**	3.3	2.8	2.7	2.1	2.8	1.9	1.3
Fe2O3t	2.12	1.84	1.58	2.85	1.81	3.03	5.03		**Cd**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
MnO	0.07	0.07	0.06	0.06	0.07	0.06	0.08		**In**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
MgO	0.66	0.39	0.29	0.91	1.37	0.82	1.99		**Sb**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
CaO	1.89	1.19	1.04	1.23	1.80	0.99	1.18		**Sn**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6
Na2O	2.89	2.69	2.88	3.17	3.18	2.69	1.85		**Te**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
K2O	3.61	3.61	4.12	4.01	3.73	3.87	4.15		**Cs**	9.9	9.3	9.6	9.6	9.5	10.4	11.5
P2O5	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05		**La**	33	31	34	29	31	32	33
BaO	<0.05	0.06	0.05	0.08	<0.05	0.05	<0.05		**Ce**	65	61	65	58	63	64	66
SrO	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		**Pr**	7	6	7	6	6	6	7
ZrO2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		**Nd**	23	21	22	21	22	23	24
LOI	6.09	5.92	5.23	6.46	6.10	5.52	6.65		**Sm**	5	4	4	4	4	5	5
Ag	<1	<1	<1	<1	<1	<1	<1		**Eu**	0.6	<0.5	<0.5	0.5	0.5	0.6	0.7
As	<5	5	<5	<5	<5	<5	5		**Gd**	5	4	4	4	4	5	4
Cu	7	10	7	11	10	11	14		**Tb**	0.8	0.7	0.7	0.7	0.8	0.7	0.6
Ni	<5	<5	<5	8	5	9	15		**Dy**	5	5	5	4	5	5	4
Pb	33	26	31	27	30	26	24		**Ho**	1.0	0.9	1.0	0.9	1.0	0.9	0.7
S	136	161	154	228	180	132	174		**Er**	3.4	3.2	3.4	3.0	3.5	3.1	2.5
V	12	<10	<10	21	11	25	46		**Tm**	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5
Zn	19	18	13	25	18	25	44		**Yb**	4.1	3.8	4.0	3.5	4.0	3.6	2.9
Li	18	17	13	28	16	24	37		**Lu**	0.5	0.5	0.6	0.5	0.6	<0.5	<0.5
Be	2.7	2.6	2.7	2.6	2.5	2.7	2.7		**Hf**	3.0	3.0	3.1	3.0	3.0	3.0	3.1
Sc	4	3	3	5	3	6	10		**Ta**	1.5	1.5	1.6	1.4	1.5	1.4	1.2
Co	3	3	2	3	2	5	10		**W**	3.0	3.1	3.2	2.8	3.1	2.9	2.3
Ga	15	15	15	15	15	16	19		**Tl**	0.8	0.9	0.8	0.7	0.8	0.7	0.7
Ge	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		**Bi**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Se	<0.5	0.8	0.8	0.6	0.7	1.0	<0.5		**Th**	30	29	31	27	30	27	23
Rb	237	229	239	218	230	233	227		**U**	4.3	4.2	4.5	3.8	4.3	4.0	3.0

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