GENESIS OF OVERGROWTH IN FELDSPAR DETRITUS IN LAMETA SANDSTONE AROUND UMRER, NAGPUR DISTRICT, MAHARASHTRA—A CASE STUDY

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INTRODUCTION

Authigenic feldspar in sandstone has become a known feature for many decade but genetic approach in relation to specific geological environment has little been attended. Making it too generalised, it has been accounted as a criterion of marine origin (CROWLEY, 1939). In recent years, geochemical studies have revealed possible reaction kinetics and phase-equilibria for such overgrowths (GARRELS & CHRIST, 1965). The present study is an attempt to draw a parity between the laboratory conditions and field observations.

Although overgrowth in feldspar is systematically underestimated in abundance and occurrence due to lack of proper attention during identification and routine analyses, but the present case cannot go unnoticed since such overgrowths constitute a significant portion of the whole rock (BERG, 1952).

The case study under investigation involves Lameta sandstone whose geology and detail petrography has rendered some conclusive data.

GEOLOGICAL SET-UP

The Umrer Coalfield stretches between latitude 20°50′45″ to 20°52′50″ N and longitude 79°16′0″ to 79°18′30″ E (about 4 sq km) and forms the part of Survey of India toposheet No. 55 P/5. It is about 46 km south-east of Nagpur and about 150 km north of Chanda. The coalfield is practically concealed under alluvium and regur.

The stratigraphy of the area as revealed by drilling is as follows:

FORMATION	LITHOLOGY	AGE
Regur and Alluvium	Black Cotton Soil, Clay and Sand	Recent
Deccan Trap	Basic volcanics	Early Tertiary
Lameta	Clay and Sandstone (Hard, medium grained)	Upper Cretaceous
	Erosional Unconformity	
Kamthi	Shale and Sandstone	Upper Permian
	Erosional Unconformity	
Barakar	Shale, Sandstone and Coal seams	Lower Permian
Talchir	Shale and Sandstone	Permo-Carboniferous
	Unconformity	
Pre-Cambrian	Metamorphics (Phyllite, Quartz-mica schists, etc.)	Pre-Cambrian

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MICRO-PETROGRAPHY

Lameta sandstones of the Umrer area are very compact, medium grained and predominantly unimodal. The sandstones are submature to mature, consisting chiefly of quartz with considerable amount of feldspar (mainly K-varieties) with muscovite as accessory mineral. Muscovite is more common than biotite and the mica flakes are often crenulated and pressed between the semi-equidimensional clastics. The sandstones belong to feldsarenite group. They contain greater amount of rock fragments than that of Barakar and Kamthis (Table 1). The intergranular spaces are often filled up with silica and iron cement (Pl. 1, Fig. 1). Subordinate amount of clay matrix is present (Table 2).

Table 1. Modal analysis of rocks (% by vol.)

Formations	Specimen No.	Modal composition of the clastic fragments		
		Quartz & Pressure metaquartzite	Feldspar and Granite gneiss	Rock fragment
LAMETA	S 9/14	68.00	21.20	10.80
	S 9/11	64.55	26.32	9.30
	S 9/19	67.33	24.86	7.79
KAMTHI	K_1	96.00	..	4.00
	K_{1B}	95.50	0.92	3.58
	K_2	97.00	..	3.00
BARAKAR	B_D	66.50	26.80	6.70
	B_2	72.10	23.22	4.68
	B_1	67.51	26.70	5.79

Table 2. Modal composition of whole rock (% by vol.) of Lameta sandstone

Specimen No.	Clastic fragment	Authigenic feldspar/unaffected feldspar	Matrix	Iron cement	Silica cement	
S 9/14	60.70	0.92	14.40	8.30	16.60 (0-5 m)	Depth increases ↓
S 9/11	62.00	0.70	20.40	3.60	14.00 (1-3 m)	
S 9/19	66.50	0.39	18.70	9.10	7.70 (5-9 m)	
S 9/2	61.20	0.87	13.90	8.70	16.20 (0.8 km)	Distance away from the pegmatite body ↓
S 9/15	63.80	0.51	16.20	6.40	13.40 (0.8-1.2 km)	
S 9/Lower 'X'	61.60	0.26	19.50	9.20	10.20 (1.2-3 km)	

In Lameta sandstone, the quartz grains are mostly sub-angular. Occurrences of well rounded quartz grains with the predominantly occurring angular quartz and feldspar grains are well marked in the present area. This may be considered as a textural inversion. Both the monocrystalline and polycrystalline varieties of quartz are present. Within the monocrystalline quartz, the non-undulatory variety predominates over the undulatory quartz fraction. The individual units within polycrystalline quartz grains are mostly flattened and extremely elongated. The number of individual units in the polycrystalline grains may vary from a few crystals (semi-composite quartz of BLATT, 1967b) to even sixteen to seventeen (composite quartz of BLATT, 1967b) crystals. Both the opaque and non-opaque mineral inclusions are present within quartz grains. The non-opaque mineral inclusions are apatite, garnet, etc. and are arranged randomly.

The feldspar grains are sub-angular to angular. They are mainly K-feldspars. The overgrowth on the feldspar grains is an interesting feature of these sandstones.

FELDSPAR MORPHOLOGY

A clear differentiation between detrital nucleus and secondary growth rim has been readily identified. The nucleus is subrounded to rounded with abraded margin and partially altered (kaolinized) with thin coating of iron cement and exhibits a cloudy appearance (Pl. 1, Fig. 2). In contrast, secondary rim shows limpid overgrowth with development of simple rhombic outline of crystal face (Pl. 1, Fig. 3) indicating a post-alteration overgrowth. Unit prism (110) and basal pinnacoid (001) together produce such simple rhombohedral form (Pl. 1, Fig. 4). The difference in composition of the rim from the core

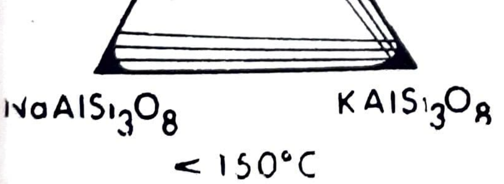


Fig. 1. The Schematic Phase diagram showing stability fields of relatively pure end numbers of feldspar group below 150°C, characteristic of sedimentary environments.

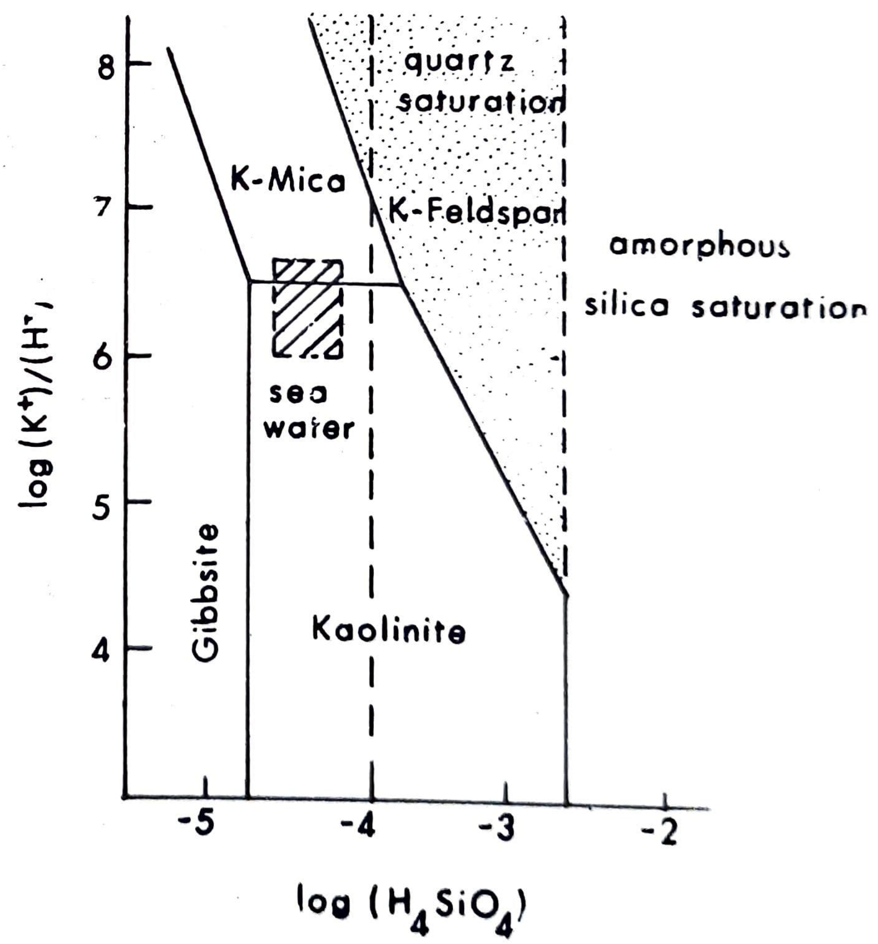


Fig. 2. Diagram showing stability field of K-feldspar and composition of sea water. (From Garrels & Christ, 1965, Fig. 10.6)

is evident from slightly different extinction position and refractive indices (Pl. 1, Fig. 5). The rim is untwinned potash feldspar (orthoclase) with microcline nucleus (Pl. 1, Fig. 6). BERG (1952), and HONES AND JEFFRIES (1940) found that the authigenic feldspars are nearly always pure alkali feldspars. It has been also established from electron probe and x-ray diffraction studies that the feldspars, whether albite or potash variety are extremely pure end members of the alkali and plagioclase solid solution series (KASTNER, 1971).

DISCUSSION

It has been generally accounted as the authigenic feldspar are commonly formed in marine environment (CROWLEY, 1939). Evidences derived from detailed sedimentological and palaeontological studies of this formation indicates a fluviatile origin for the Lameta sediments in this area and a marine origin appear to be highly improbable. The secondary growth of feldspar, whether a preburial or post consolidation happening is still under dispute (GRANDJEAN, 1910; VAN STRAATEN, 1948). PETTIJOHN (1975) believes that the circulating meteoric water plays no part for such growth; rather connate waters are responsible for such formation during post burial time.

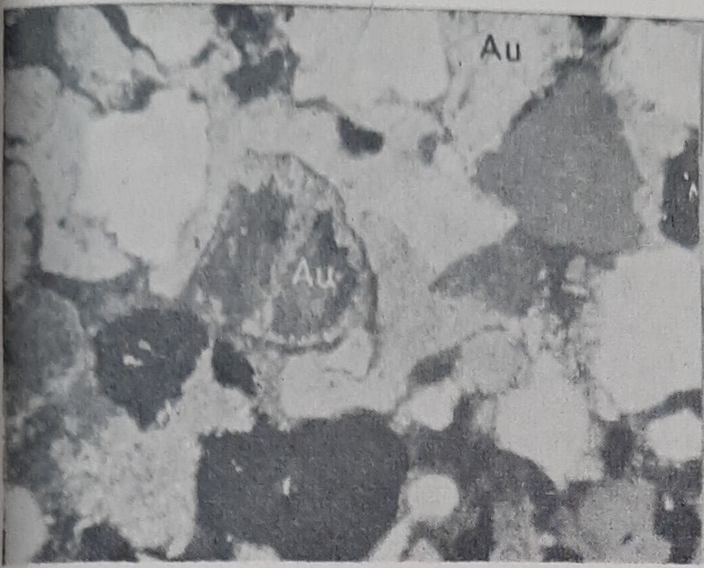
It has been established that the pure end members of feldspar group are stable below 150°C (Text-fig. 1) and therefore, can suitably match sedimentary environment, although moderately elevated temperature is necessary for such overgrowth (HEMLEY & JONES, 1964). According to them, a consideration of temperature coefficient for the secondary origin of feldspar may presumably be associated with moderate to deep burial condition. But in the present case, chance of deep burial for the sandstones has remote possibility, rather the source of temperature might be the immediately overlying volcanogenic rock (Deccan Trap) during its molten stage.

The chemical conditions for their formation have been well documented through equilibrium diagrams and experimental studies (GARRELS & CHRIST, 1965; HESS, 1966). From this kind of diagram (Text-fig. 2), the field of K-feldspar is extended below for even lower log $(K^+)/(H^+)$ value provided an excess silica concentration is present in the solution. Thus the reaction may take this reverse path in presence of a high enough concentration of dissolved silica and a high enough ratio of Na^+/H^+ or K^+/H^+ activities which normally goes from left to right for hydrolysis of feldspar (kaolinitisation).

$$\underset{\text{(K-feldspar)}}{2\,KAlSi_3O_8} + 2\,H^+ + 2\,HCO^-_3 + 9\,H_2O \leftarrow \underset{\text{(kaolinite)}}{Al_2Si_2O_5\,(OH)_4} + 4\,H_4\,SiO_4 + 2\,K^+ + 2\,HCO^-_3$$

PETTIJOHN, POTTER AND SIEVER (1972) outlined the geologic conditions for the authigenic growth of feldspars from the above chemical principles as (i) abundant K^+ and/or Na^+ ions that may come from pore waters of high salt concentrations, (ii) a source of silica, either from skeletal parts of organisms or from hydrolyzing silicates and (iii) moderately elevated temperature through moderate to deep burial of the sediments.

The pegmatite bodies occurring in the nearby area contain abundant K-feldspars which by process of dissolution increased high enough ratio of $(K^+)/(H^+)$ activity of circulating meteoric water as this is apparent from fall of the frequency of authigenic feldspars when counted laterally away from those pegmatite bodies (Table 2). The role of circulating meteoric water, instead of connate waters in pore spaces is also evident from the rise of frequency of such overgrowths when counted vertically upward (Table 2). The source of silica is the already existing surrounding rock from which the hydrolyzing



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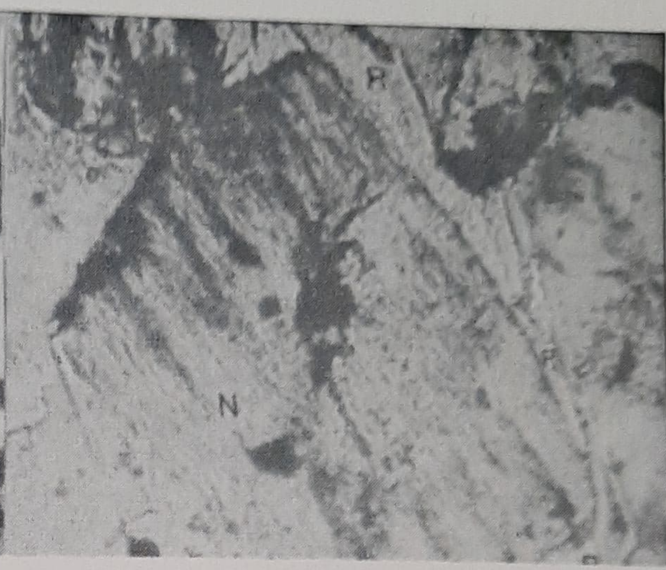

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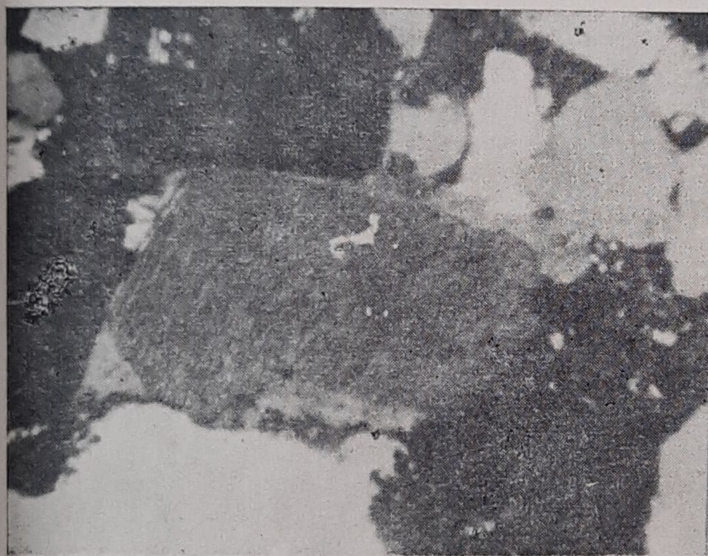

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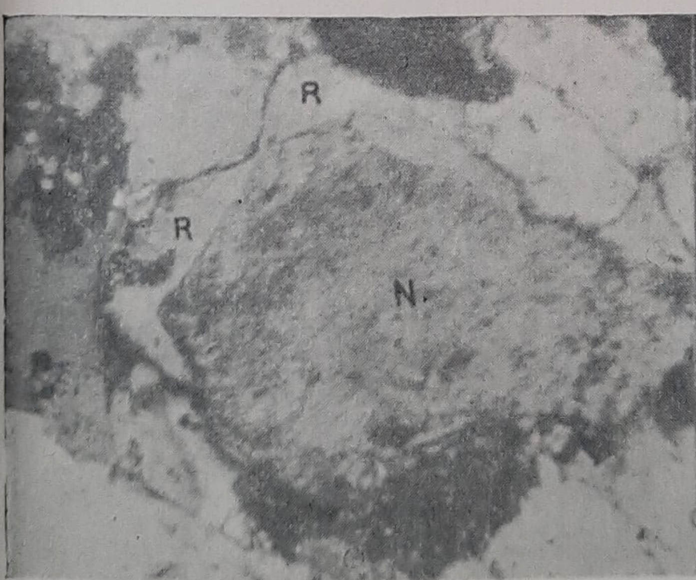

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silicates yielded SiO_2 through decomposition of minerals. This is revealed from modal composition of silica cement in sandstone (Table 1).

The temperature coefficient required for such overgrowth was probably attained through the invasion of molten magma as referred earlier.

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REFERENCES

BERG, R. R. (1952). Feldspathized sandstone. *J. Sed. Petrology.* **22** : 221-223.

BLATT, H. (1976). Original characteristics of clastic quartz grains. *J. Sed. Petrology.* **37** : 401-424.

CROWLEY, A. J. (1939). Possible criterion for distinguishing marine and non-marine sediments. *Bull. Am. Assoc. Pet. Geol.* **23** : 1716-1720.

GARRELS, R. M. & CHRIST, C. L. (1965). *Solutions, minerals and equilibria.* Harper and Row, New York.

GRANDJEAN, F. (1910). Deuxieme note sur le feldspath neogene des terrains sedimentares nonmetamorphique. *Bull. Soc. France Mineral.* **33** : 92-97.

HEMLEY, J. J. & JONES, W. R. (1964). Chemical aspects of hydrothermal alteration with emphasis on hydrogen metasomatism. *Econ. Geol.* **59** : 538-569.

HESS, P. C. (1966). Phase equilibria in some minerals in the K_2O-Na_2O-Al_2O_3-SiO_3-H_2O system at 25°C and 1 atmosphere. *Am. Jour. Sc.* **264** : 289-309.

HONES, A. P. & JEFFRIES, C. D. (1940). Authigenic Albite from Lowville Limestone at Belleforte, Pennsylvania. *J. Sed. Petrology.* **10** : 12-18.

KASTNER, M. (1971). Authigenic feldspars in carbonate rocks. *Am. Mineralogist.* **56** : 1403-1442.

PETTIJOHN, F. J. (1975). *Sedimentary Rocks.* 3rd Ed., 628 p. Harper and Row, New York.

PETTIJOHN, F. J., POTTER, P. E. & SIEVER, R. (1972). *Sand and sandstone.* 618 p. Springer-Verlag, Berlin.

VAN STRAATEN, L. M. J. U. (1948). Note on the occurrence of authigenic feldspars in non metamorphic sediments. *Am. Jour. Sc.* **246** : 569-572.

EXPLANATION OF PLATE 1

1. Lameta sandstone showing authigenic feldspars (Au) and quartz grains with silica and iron cement in the intergranular spaces. ×25.
2. Feldspar grain showing partially altered nucleus (N) and limpid overgrowth rim. (R). ×360.
3. Feldspar showing simple rhombic outline of the crystal by limpid evergorwth rim (R) around a turbid nucleus (N). ×80.
4. Beautiful rhombohedral form around the anhedral nucleus (N). ×80.
5. Micrograph showing a clear distinction betwen the nucleus and the secondary rim. ×80.
6. Feldspar showing microcline nucleus (N) and untwinned potash feldspar rim (R). ×360.