

Fluid Inclusion Studies of Charnockites and Garnetiferous-Quartzofeldspathic Gneisses in Vijayapuri Area of Southern Granulite Terrain, Tamilnadu

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Abstract:

This Geologists show much interest in recent years to high-grade metamorphic rocks and particularly on granulites of southern peninsular India. Granulite shows preservation of near peak metamorphic mineral assemblages and minerals developed during retrograde metamorphism. The recent studies of fluid inclusions from the South Indian granulites have shown that CO₂-rich inclusions are the common fluid species present in these rocks (Newton, 1989; Santosh et al., 1991; Srikantappa et al., 1992, Touret, 1971). Though now generally agreed those carbonic fluids are the dominant fluids present in South Indian granulites and in some parts of eastern ghat granulites (Srikantappa and Bhaskar Rao, 1995). The problem is whether these fluids are syn-metamorphic or postmetamorphic with respect to peak metamorphic conditions of charnockite granulite.

Keywords —Fluid Inclusion, charnockite granulite, metamorphic mineral, Quartzofeldspathic.

I. INTRODUCTION

This The study area falls in the survey of India Toposheet No: 58E/12. Vijayapuri area is located about 9km south-west of Perundurai on the road leading to Erode to Coimbatore NH-47. It falls in the north-west part of the study area. Vijayapuri is located on the way to Erode to Thiruppur broad gauge Railway line of Southern Railway. The study area lies in between the North latitude 11°8'00'' and 11°15'00'' and East longitude 77°30'00'' and 77°40'00'' which includes parts of Vijayapuri area and the surroundings of Perundurai taluk, Erode district, Tamil Nadu.

In recent years, there has been growing interest in fluid inclusion studies in rocks. The common fluid phases present at different stages in the rocks have been first recognized by early petrographers Sorby, (1858), Zirkel, (1873). In the recent years the study of fluid inclusions in the metamorphic rocks help us to understand the process of metamorphism and also provide useful information on the nature and composition of

intergranular fluid during metamorphism (Touret, 1974, Swananberg, 1980). metamorphism in granulites (Touret 1995). Most of the fluid inclusions observed in high -grade metamorphic rocks represent either near peak or peak point metamorphic The occurrence of early aqueous fluid which appear to have been preserved despite high-grade intergranular fluids. This is because of the fluid inclusions that were trapped during the prograde pairs of the P-T-t path and in most cases it would have been re-equilibrated during peak metamorphic conditions. Fluid “absent” or Fluid “present” metamorphic process have been explained for the origin of granulites (Lamb et al., 1991; Santosh et al., 1991, Srikantappa et al., 1992). A careful study of the chronology of fluid inclusions (relative timing of formation) evaluated based on development of microfractures related to deformation and mineral reactions in combination with mineral P-T estimates a clockwise (adiabatic) or anticlockwise

P-T-t path may be inferred.

1. Isolated fluid inclusion (IFI) which do not occur in quartz

2. Trail bound fluid inclusion (TBFI) which occurs in a planar array healed fractures.

The IFI are oval, rectangular, rounded to relative crystal shape with size ranging from 6 to 15mm. The TBFI vary in shape from rounded, oval to irregular type with size ranging from 8 to 12mm. The IFI is mainly concentrated in the centre of the grains and less in numbers in the rim of the grains, whereas TBFI occur in any part of the grains. The TBFI occur in crack healing all fracture bound surface. Several generations of fluid inclusions results from continuous fracturing and leakage of inclusions in response to pressure difference between these inclusions and its surrounding (Hollister et al., 1979; Sission et al., 1981; Crawford et al., 1984).

The observed fluid inclusions in the charnockites and garnetiferous quartzo feldspathic gneisses of the area indicate that the quartz grains show occurrence of mainly IFI inclusions with size range from 4-10mm and shape is oval to rounded. It also shows the presence of planar arrayed in two sets along with CO₂ and CO₂-H₂O fluid inclusions. They are oval and rectangular to round in shape with size ranging from 5 to 14mm.

III. MICROTHERMOMETRIC RESULTS

All Microthermometric data for different type of inclusion observed in rock types studied from the area of investigation are presented in Table-21. It can be that all the inclusions are showing temperature of melting (T_m) closer to -56.6°C (Triple point of CO₂ melting temperature) suggesting that they are CO₂-rich fluids. All the fluid inclusion observed in the rock types under question indicate the temperature of homogenization (Th) for CO₂ inclusions in different quartz grain are reported in Table - 21.

Quartz

The CO₂ related fluid inclusions (IFI) in quartz grain from para charnockitic granulites show the (Th) variations from 15 to 25°C. This indicates the presence of high-density fluids (1.04-0.73) with peak (Th) which varies from 10-5 and density 1.0 to 0.95 g/cc. The CO₂-H₂O inclusions also are

noticed in quartz grain. The CO₂ rich inclusion melt at -56.6 to 57.2°C and CO₂ Th of CO₂ 12 and final Th of CO₂-H₂O is 260-340°C.

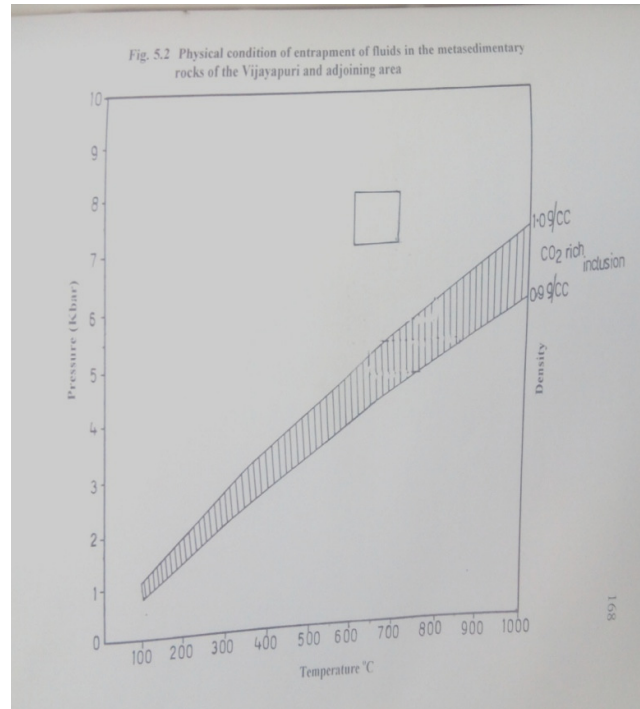


Fig. 2

ENTRAPMENT OF FLUIDS PHYSICAL CONDITION

In the charnockitic granulite the CO₂-rich inclusions show a high-density range from 1.0-0.765 gm/cc and in gneissic rocks it is very low in density.

Interpretation

Based on the estimation of P-T for the charnockitic granulite and garnetiferous quartzo feldspathic gneiss, it can be noted that the pressure range between 6.0 and 7 Kb and temperature from 550°C to 750°C. The temperature, pressure and CO₂ densities observed in charnockitic granulite and garnetiferous quartzo feldspathic gneisses are plotted. The CO₂ rich inclusions show a maximum density ranging from 1.00-0.90 g/cc. This density data closely corresponds with the mineral P.T indicating their carbonic fluids presence during granulite facies metamorphism of the area (Fig. 5.2).

SOURCE OF CARBONIC FLUID

facies The source for carbonic fluids in charnockites/granulite is highly debatable. Various hypotheses have been proposed for the source of CO₂ fluids during granulite facies metamorphism are as follows:

1. Insitu origin of CO₂ fluids by alteration of residual fluids by absorption of H₂O into anatexitic melts (Hollister and Burruss, 1976; Brennan and Watson, 1987; Crawford and Hollister, 1986).
2. Immiscible carbonate from tonalitic diapirs (Touret, 1985)
3. Decarbonation of crustal limestone and dolomites (Glassley, 1988).
4. Oxidation of graphite during metamorphism (Kreulen & Schuling, 1982).
5. An out gassing of mantle hotspot (Harris et al., 1982).

TABLE - 21
MICROTHERMOMETRIC DATA OF CO₂ AND CO₂-H₂O INCLUSION FROM THE VIJAYAPURI AREA

| Sample No. | Type of Mn. | CO ₂ inclusion | | | CO ₂ -H ₂ O inclusions | | | | H ₂ O inclusion | | | |
|------------|-------------|---------------------------|-----------|-----------------|--|-----------|--|------------|----------------------------|------------------|-----|-----------------|
| | | Tn. | Tn. | Density in glcc | Th (CO ₂) | Den. glcc | CO ₂ -H ₂ O (Th) | Den. glcc | Tn | Salinity W% NaCl | Th | Density in glcc |
| AB-28 | Charnockite | -58.6 | -15 to 25 | 1.0-0.73 | 12 | 0.866 | 260-340 | 0.825-0.60 | 4 to -6 | 5 | 190 | 0.91 |
| AB-10 | Charnockite | -59.6 | -10 to 20 | 0.987-0.78 | - | - | - | - | - | - | - | - |
| AB-10A | Gneiss | -58.0 | 15 to 30 | 0.82-0.64 | - | - | - | - | - | - | - | - |

AB-28, AB-10 - Charnockitic granulite; AB-10A - Garnetiferous quartzo feldspathic gneiss

Fig. 3

6. Internally generated CO₂ fluid release model (Srikantappa et al., 1985; Raith and Srikantappa, 1993).

7. Release of CO₂ from deep seated granulite fluid inclusions (Stable et al., 1987)

8. Exsolution from crystallization of deep crustal mafic or intermediate rocks (Touret, 1971).

The above models have been evaluated in the light of field relationship and petrographic features observed in granulite facies rocks around Vijayapuri. Although the process of minor partial melting is observed in enderbitic charnockitic granulites, now large-scale partial melts have been recorded. This rules out the first hypothesis described above. Major and trace element geochemistry of enderbitic-charnockitic granulites indicate their tonalitic compositions. These could represent tonalitic diapirs and they could serve as source of CO₂ (Touret, 1985).

There are no calc-silicate rocks occurring in the area, which precludes the possibility of carbonate rocks as source for CO₂. Graphites, which are so commonly reported from Kerala khondalite belt, south India is completely, absent in the granulite facies lithologies of the study area.

The major source for CO₂ for the granulite facies appears to be either the basic intrusive in the area or they could have been derived from the associated metasedimentary lithologies of the area (carbonate).

IV. CONCLUSIONS

In this study area is consist of of Carbonic Fluid, meta basics and metaultramafic lithounits are present. There is a general unanimity that the granulites have suffered high temperature and pressures of regional metamorphism. Most of the granulites show lack of mineral assemblages during the formation of prograde metamorphism, as a result of high degree of deformation and intense metamorphism associated with the formation of granulites on a regional scale. The studies of fluid inclusions from the South Indian granulites have shown that CO₂-rich inclusions are the common fluid species present in these rocks.

REFERENCES

1. ALLEN, P., CONDIE, K.C. and NARAYANA, B.L., (1983). *The archaean low-to high grade transition in the Krishnagiri-Dharmapuri area, Tamil Nadu, South India. In: SM Naqvi and J.J.W. Rogers (eds) precambrian of South India, Geol. Soc. India. Mem. 4, pp. 450-461.*
2. CONDIE, K.C., ALLEN, P. and NARAYANA, B.L., (1982). *Geochemistry of the archaean low to high grade transition*

in southern India: *Contrib. Mineral. Petrol.*, Vol. 81, pp. 157-167.

3. DAHL, P.S., (1980). *The thermal-compositional dependance of Fe+2 – Mg distribution between coexisting garnet and pyroxene. Application to geothermometry.* *Am. Min.*, Vol. 65, pp. 854-866..
4. GRADY, J.C., (1971). *Deep main faults in South India,* *Jour. Geol. Soc. India*
5. GREEN, T.H., (1969) *High-pressure experimental studies on the origin of anorthosite* *Can. Jour. Earth. Sci.*, Vol. 6, pp. 427-440.
6. HOBBS, B.E., MEANS, W.D. and WILLAMS, P.F. (1976). *An outline of structural geology.* John Wiley & Sons, New York.
7. Le MAITRE, R.W., (1976). *The chemical variability of some common igneous rocks.* *Jour. Petrol*, Vol.17, pp. 589-637.
8. NEWTON, R.C. (1987). *Petrologic aspects of precambrian granulite facies terrains, bearing on their genesis.* In: A. Kroner (Ed) *proterozoic lithopheric evolution and geodynamics.* *Am. Geophy. Union.*, No. 1726, pp. 11-25.
9. WELLS, P.R.A., (1979). *Chemical and thermal evolution of archaean sialic crust.* *Southern West Greenland Jour. Petrol.*, Vol. 20, pp. 187-226.
10. ZIRKEL, F., (1973). *Die mikroskopische beschaffenheit der Mineralien und Gesteine.* Wilhelm Engelmann, Leipzig, 502.
11. Edwin Roedder, 1971, *Fluid inclusion studies on the porphyry-type ore deposits at Bingham, Utah, Butte, Montana, and Climax, Colorado*, 98-118.
12. Ronald J.Bakker, 2003, *Package FLUIDS 1. Computer programs for analysis of fluid inclusion data and for modelling bulk fluid properties*, 3-23.
13. BMJ, 1998, *Fluid resuscitation with colloid or crystalloid solutions in critically ill patients: a systematic review of randomised trials*, 316:961.
14. E. C. HANSEN, R. C. NEWTON, A. S. JANARDHAN, 1984, *Fluid inclusions in rocks from the amphibolite-facies gneiss to charnockite progression in southern Karnataka, India: direct evidence concerning the fluids of granulite metamorphism*, 1525-1314.
15. M. Santosh, N. B. W Harris, D. H. Jackson, and D. P. Matthey, 1990, *Dehydration and Incipient Charnockite Formation: A Phase Equilibria and Fluid Inclusion Study from South India*, Vol:98.