Geochemical and Geostatistical Analysis of Iron ore groups in Northern Tamil Nadu

Msc Dissertation/Viva voce presentation

Presented by

B. Venkateshwaran
II. M. Sc. Applied Geology
Department of Geology
Periyar University
Salem - 636011

Under the Guidance

Dr. A. Thirunavukarasu. M. Sc. Phd.,
Assistant professor
Department of Geology
Periyar University
Salem - 636011

Contents

Introduction

The state of Tamilnadu reserves over 500 million tonnes of magnetiite with an average grade of 38 iron in the major deposits of Salem and Dharmapuri.
The study area covers a three loactions. These are Kanjmalai, Thirthamalai, Godhumalai.
To determine the dominating factors on these locations and distinguished by each of loactions by another locations.
Performing the factor analysis and discriminant analysis and interpret the results. Where the analysis made on MATLAB programming.

Aim and Objective

The geochemical and geostatistical analysis of iron ore groups in northern tamilnadu.

To determine the dominating factors of each deposits and elaborate the each factor of the each region briefly by the mineralogical identities. In three regions, the each pair considered a two regions (totally three pairs) distinguished by the linear discriminant analysis based on discriminant analysis.

STUDY AREA

The area selected for this study are located in the northwestern part of Tamil Nadu.

The Salem district comprises of Kanjamalai and Godhumalai region. The Dharmapuri district comprises of Thirthamalai region.

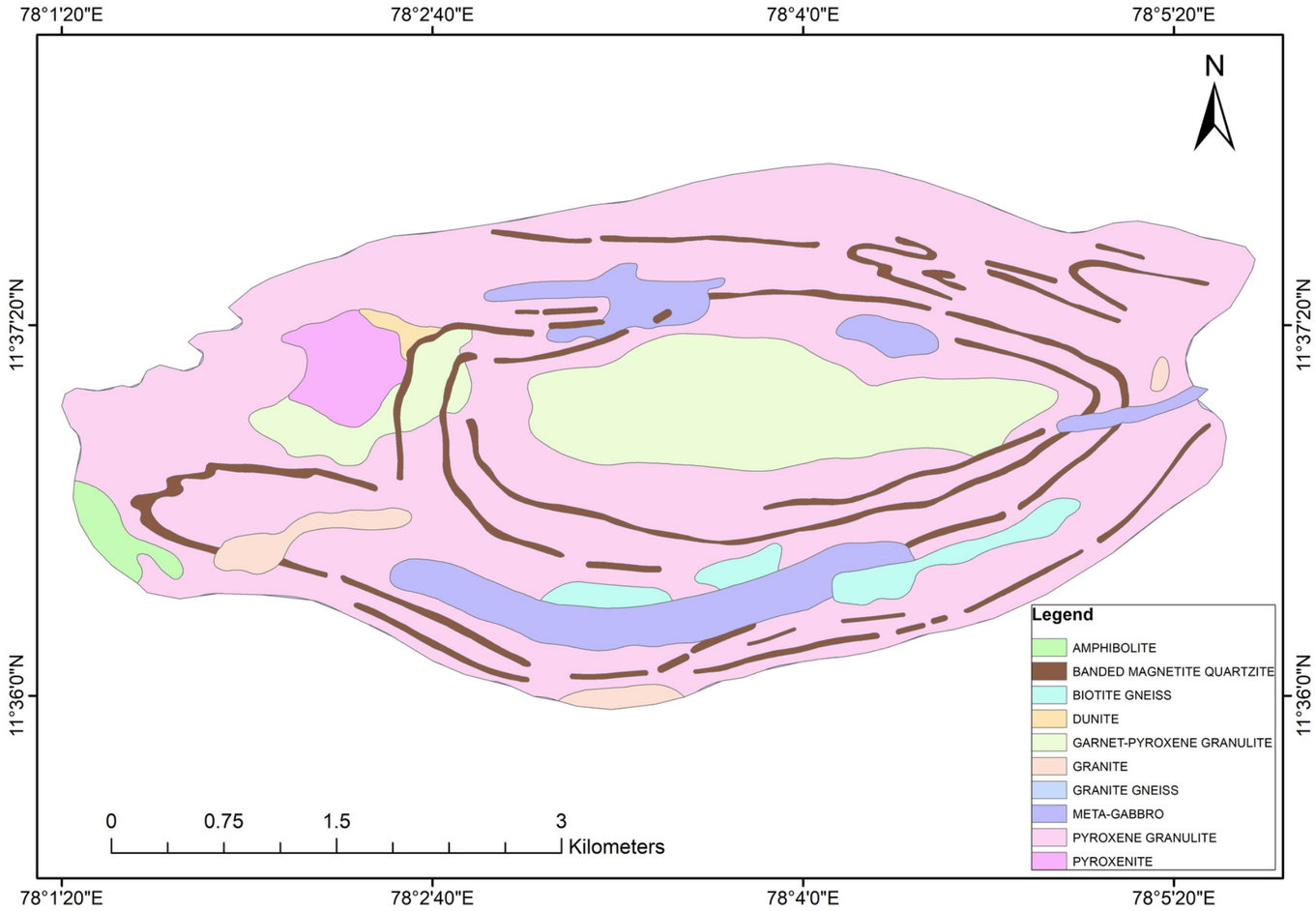
Kanjamalai

Kanjamalai is one of the well-known banded iron formation hills (Banded Magnetite Quartzite) in Tamil Nadu, consists of garnet-amphibolite gneiss at top of the hill.

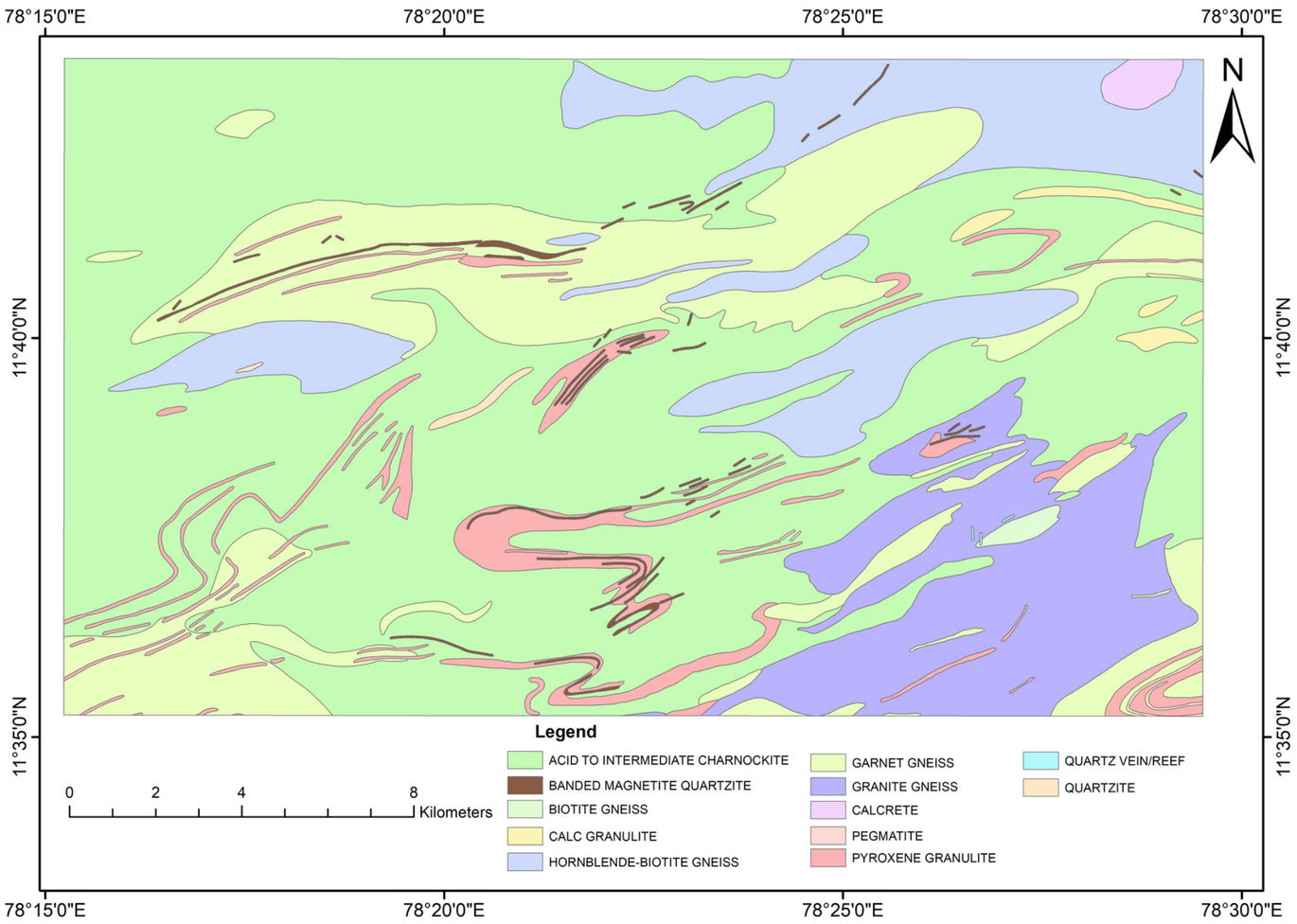
These are typically banded and rich in iron and iron silicates of meta-sedimentary rocks.

The granulite region is composed mainly the rocks magnetite quartzite(iron ore), garnetiferrous pyroxene granulite, hornblende biotite gneiss and amphibolite.

These contains three bands, where Lower, Middle and Upper.



Kanjamalai Map



Godhumalai Map

Godhumalai

The study area of Godumalai lies between north latitude 78°18’ to 78°24’ and east longitude 11°38’ to 11°42’ covering an area of 175 sq.km towards East to West direction.

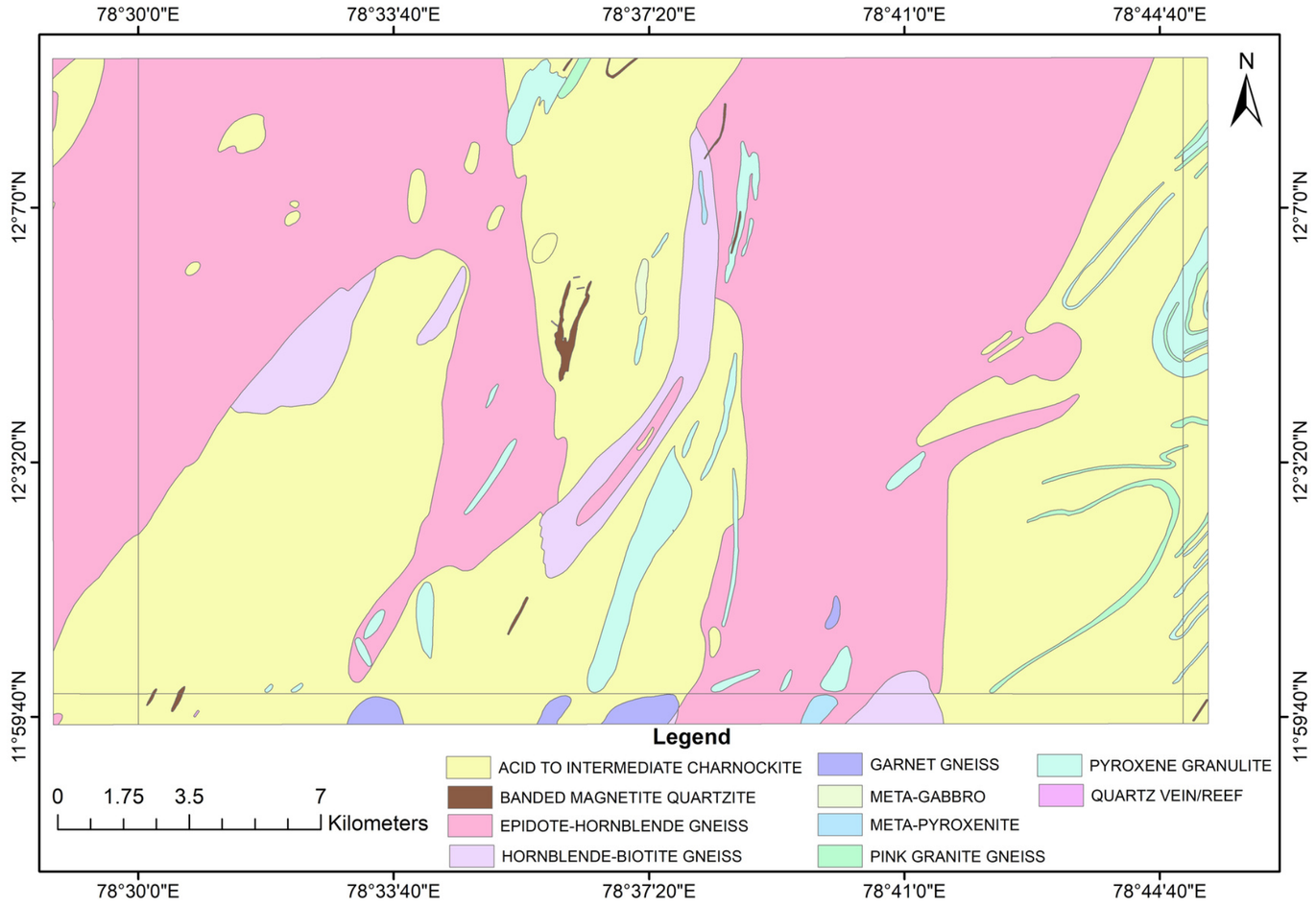
Metamorphism in this areas converted hematite into magnetite and the jasper into quartz. Hornblende biotite gneiss covers the entire hill and the lithology of the surrounding area includes amphibolite and pyroxene granulite. The thickness of the ore bands is 3-5m.

Thirthamalai

The study area falls between the latitudes N 12 03’ and 12 06’ and longitudes E 78 35’ and 78 38’ in the Survey of India Toposheet No.58 L/12.

These are banded magnetite quartzite differentiated on the basis of presence of magnetite and quartz and having an iron content of 35-40 percentage (low-grade iron ores.

The BMQ deposits are associated with pyroxene granulite, charnockite, hornblende-gneisses and pegmatite.



Thirthamalai Map

Methods and Materials

The analysis mainly consist of three regions geochemical data and these have been collected from various papers.
The three regions major and trace elements were collected from different amounts of samples.
kanjamalai - 10 samples, Godhumalai - 11 samples, and Thirthamalai - 20 samples.
Major elements - SiO_2, Fe_2O_3, TiO_2, Al_2O_3, FeO, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, C, S.
Trace elements - Sr, Rb, Cr, Co, Ni, Cu, Y, Ba, V, Zn, Zr, Sc.

MATLAB Programming

Data Normalization

In order to normalize the data we need convert all three regions of geochemical data into same proportion to find out the factors, which gives as better result.

In geochemical data presentation the major oxides values are reported in weight percentage(%) and trace elements values are reported in ppm.

To eliminate the influences the major components are correlated using below equation.

$$\log\left(\frac{C}{(1-C)}\right)$$

Where,

$$C = \frac{W}{100} \quad \textbf{(Major)}$$

$$C = \frac{W}{1{,}000{,}000} \quad \textbf{(Trace)}$$

Factor Analysis

Factor analysis operates on the notion that measurable and observable variables can be reduced to fewer latent variables that shares a common variance and are unobservable, which is known as reducing dimensionality. These unobservable factors are not directly measured but are essentially hypothetical constructs that are used to represent variables

Data Normalization

The linear regression (correlation) between any two components is dangerous because of the closure constraints as well as non consistency of variance.

Factor Analysis

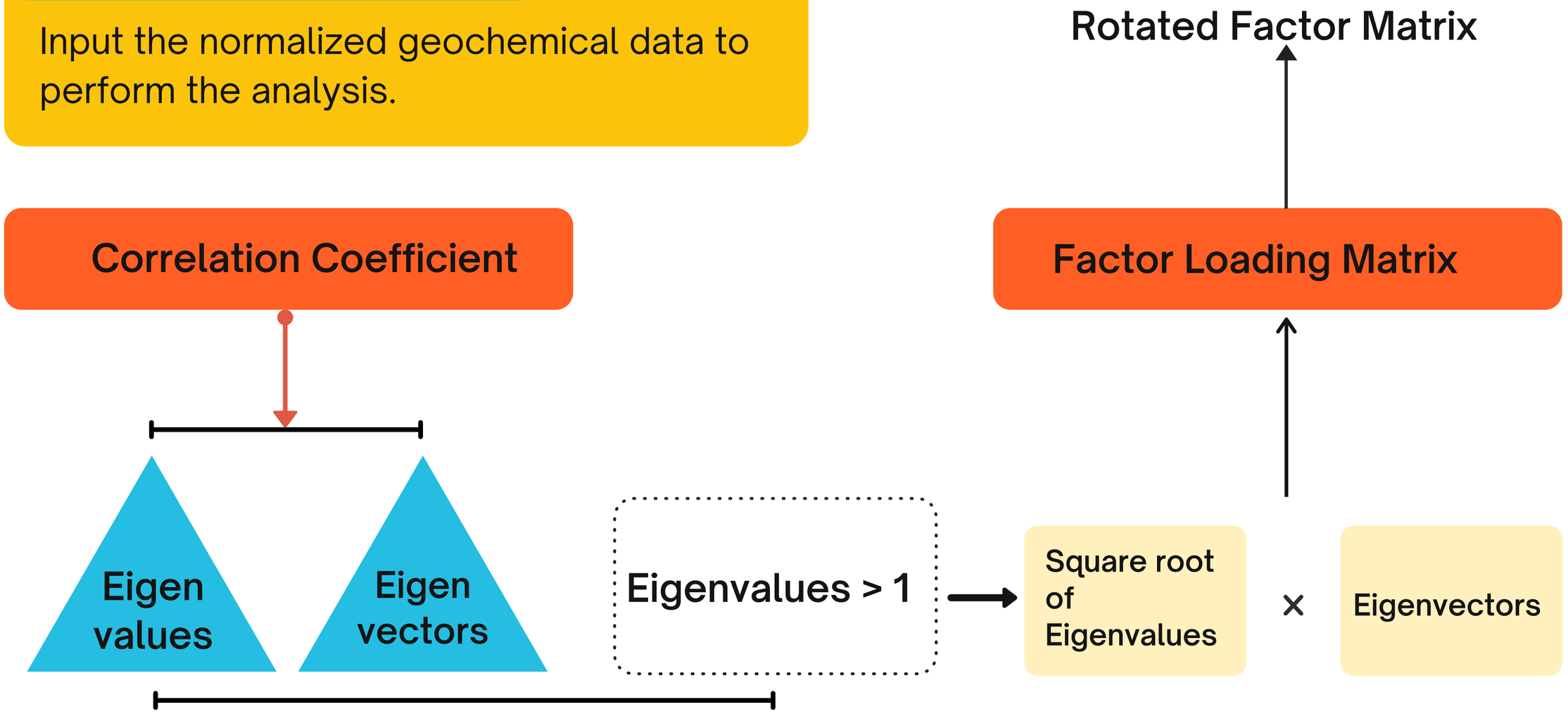
The factor analysis used to examine the large datasets that consist of several variables can be reduced by observing "groups" of variables (factors) - that is, factor analysis assembles common variables into descriptive categories.

Factors

The factor scores determine the dominance of the Mineralogical assembleages.

Factor Analysis

Input the normalized geochemical data to perform the analysis.



Results and Interpretation

Kanjamalai

Fe2O3 (+0.7454)

TiO2 (-0.9441), Al2O3

Low values of Na2O and K2O

FeO (+0.6265)

CaO (-0.0349)

Ni, Cr, Zr, Y, V, Ti and Sc

Thirthamalai

Al2O3 (-0.9041)

Fe2O3 (-0.9937)

the high amount of the Cao indicators of the non-volcanogenic origin.

Fe2O3 (0.6029)

MnO (0.7620)

Na2O (0.7895)

Godhumalai

SiO2 (0.7078)

CaO (0.8707)

Ni, Cu (0.8959)

Al2O3 (-0.7734)

MgO (0.7162)

The orange color star imposing First Factor.

The green color star imposing Second Factor.

The blue color star imposing Third Factor.

The Brown color star imposing Fourth Factor.

kanjamalai Results

- The ferrous rich minerals headed on the first factor and the processes of the iron ore. Hematite is the major altered mineral phase due to oxidation and hydration.
- The minimum value of the Na2O and K2O suggest the contribution of non-volcanic provenance sources.
- The FeO and these shown based on sediment environment to place a limonite rocks proportion it continuely showing their imprints in the last factor and these represent the suborder rocks assemblages hypersthene and grunerite.
- The variations within Ni, Cr, Zr, Y, V, Ti and Sc indicates the mixing of terrigeneous sources in the formations
- the higher values of Al2O3 and TiO2 indicate higher amount of clastic contaminant and strongly suggest the input of clastic sediment matter in the iron formations.
- the low amount CaO, where iron is precipitated as ferric oxide, ferric hydroxide, sulphate or carbonate. as there are no carbonates in kanjamalai, the derivation of iron from siderite is not valid.
- Iron might have been brought to the depositional site as ferric hydroxide (hydrosal) in colloidal solution.

Thirthamalai Results

- In thirthamalai, the first factor comprises of Al2O3 (-0.9041) and Fe2O3 (-0.9937) with the negative signature that encountered a process of weathering and erosion.
- The modification of iron formations due to non-volcanic activities.
- Due to the absence of evidence of any volcanic derivation of iron and silica, and marine source, the mechanism of the weathering of land masses appears to be logical.
- In second factor corresponding to the assemblages of the iron foramtions, where the Fe2O3 (0.6029) considered the formations of magnetite-quartz rocks. The magnetite quartzite, it shows low concentration of Al2O3, CaO and MnO, Na2O and K2O which infers the non-volcanogenic origin.
- The banding of the iron-formation of the study area may be considered that the seasonal climate variations and cyclical variations in basinal chemistry which have played an important role in the development of banding.

Godhumalai Results

- The first factor implies the major elements of SiO2 (0.7078) at the high proportion which results to the major quartz rich rocks emplaced.
- CaO indicates the sediment environment heads upon dominating once and Ni, Cu alternating the minor amounts associated rocks. The quartz rich developing the purely aggregates of quartz (jasper).
- The second factor enrolls the Al2O3 proportion, which keeps a placement of plagioclase feldspar and may acquire to develop amphibole rich contents of the rocks.
- The third factor and the fourth factor enclosed the dominance and the MgO (0.7162) step out through the final importance.