CHAPTER III

COLLECTION AND EXPERIMENTAL PROCEDURES

3.1 COLLECTION, SHAPING AND MEASUREMENT

Despite the handicap that poor exposures are found in Mysore State, 91 oriented samples were collected from 10 different dykes, during the winter of 1967-1968. The samples were collected mainly from road cuttings, quarries and river beds, in order to avoid the heavy oxidizing condition found in a tropical country like India. Locations of the dykes sampled are shown on the geological map of Mysore State in Fig. 1. Each sample, when in situ, was marked with an arrow, representing the geographical North, using Brunton Compass. Further, horizontal lines were drawn with the use of a precision spirit level.

From each oriented sample, four to six cores were drilled normal to the horizontal plane, cut into small cylindrical specimens (disk) and marked with a reference to the site and sample.

A summary of the collection of samples with site location, number of samples and specimens studied, and the trend of the dykes are listed in Table 3.

3.2 EXPERIMENTAL PROCEDURES

Precision and accuracy of paleomagnetic measurements are dependent upon sophisticated instrumentation and magnetic stability of the samples.
<table>
<thead>
<tr>
<th>Site No.</th>
<th>Reference letter</th>
<th>Location</th>
<th>No. of samples</th>
<th>Trend of dike</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ICD</td>
<td>Near Chitaldrug</td>
<td>12</td>
<td>N 70° W</td>
</tr>
<tr>
<td>2</td>
<td>2CD</td>
<td>14°0'10&quot; E 76°0'27&quot; N</td>
<td>13</td>
<td>N 70° W</td>
</tr>
<tr>
<td>3</td>
<td>3CD</td>
<td>14°0'15&quot; E 76°0'25&quot; N</td>
<td>4</td>
<td>N 70° W</td>
</tr>
<tr>
<td>4</td>
<td>4CD</td>
<td>14°0'15&quot; E 76°0'24&quot; N</td>
<td>8</td>
<td>N 70° W</td>
</tr>
<tr>
<td>5</td>
<td>5CD</td>
<td>12°0'25&quot; E 76°0'14&quot; N</td>
<td>22</td>
<td>N 15° W</td>
</tr>
<tr>
<td>6</td>
<td>KD</td>
<td>12°0'25&quot; E 76°0'14&quot; N</td>
<td>13</td>
<td>N 15° W</td>
</tr>
<tr>
<td>7</td>
<td>7CD</td>
<td>12°0'18&quot; E 76°0'14&quot; N</td>
<td>21</td>
<td>N 15° W</td>
</tr>
<tr>
<td>8</td>
<td>8CD</td>
<td>12°0'20&quot; E 76°0'11&quot; N</td>
<td>3</td>
<td>N 15° W</td>
</tr>
<tr>
<td>9</td>
<td>CK</td>
<td>12°0'44&quot; E 77°0'31&quot; N</td>
<td>4</td>
<td>N 70° W</td>
</tr>
<tr>
<td>10</td>
<td>ND</td>
<td>12°0'44&quot; E 77°0'31&quot; N</td>
<td>22</td>
<td>N 70° W</td>
</tr>
</tbody>
</table>
In addition to the primary component, rocks may take up secondary components of magnetization, subsequent to their formation. This is due to effect of the geomagnetic field, lightning strokes, weathering effects etc. The secondary effects, in these samples, completely mask the primary component, resulting in a large scattering of the directions of magnetization. It is, therefore, necessary to study the stability of magnetization of a rock formation and remove the secondary components, if any. Later, computing the mean remanent magnetic directions, and intensities of NRM and assessing the stability of magnetization are done as briefly discussed below.

3.2.1 MEASUREMENT OF DIRECTIONS AND INTENSITIES OF RM

Directions and intensities of remanent magnetization of all the specimens were measured on an astatic magnetometer in a field-free space, set-up at the Paleomagnetism Division of the National Geophysical Research Institute. The sensitivity of the instrument is of the order of $3 \times 10^{-7}$ oersteds/cm deflection with a four meter optical path.

The intensity of each specimen was measured in three perpendicular directions with respect to geographic North. Measurements were taken in twelve orientations of the specimen with respect to the magnetometer in order to minimize anisotropy effects. Declination is measured, east of geographic North from $0^\circ$ to $360^\circ$ and inclination or (dip) from $0^\circ$ to $90^\circ$ downwards (positive) or upward (negative). The errors in measurement of the declination and inclination are not more than $\pm 5^\circ$. 
3.3 STABILITY TESTS

For testing the stability of NRM of rocks, Graham (1949) proposed a few field tests which can be used only in certain special cases. Apart from these, there are two laboratory techniques useful in "cleaning" the unwanted components of magnetization.

The first technique is known as the alternating current demagnetization techniques (a.c. demagnetization), for which an instrument was developed initially by Creer (1961). The second, the thermal-demagnetization technique was developed by Wilson (1962). This technique, besides providing information about the stability, enables us to determine the Curie points of ferromagnetic minerals present in the rock.

In the present studies both a.c. and thermal demagnetization techniques are used for assessing the stability of NRM of rocks and for magnetic cleaning.

3.3.1 INSTRUMENTAL AND EXPERIMENTAL PROCEDURES FOR A.C. AND THERMAL DEMAGNETIZATION

An a.c. demagnetization apparatus was constructed in the National Geophysical Research Institute, Hyderabad, which is similar to that of Creer (1961). An important part of this apparatus is a specimen holder, which is made up entirely of perspex and capable of rotating simultaneously in two perpendicular planes, at the centre of a demagnetizing coil system. It is powered with a motor with frequencies of rotation in the ratio of 30:32. The whole assembly is kept in a
field-free space, using Helmholtz coils. The field coil is connected in series with a suitable condenser to make the whole circuit resonant to 50 CPS, the commercial mains frequency. In this set-up the peak-field at the centre of the coil is 100 oersteds/ampere. The coil takes up a maximum current of 10 amperes when 220 volts a.c. supply is used.

3.3.2 EXPERIMENTAL PROCEDURES (A.C.)

The specimen to be demagnetized was kept in the specimen holder, and the motor was run. The current in the demagnetizing coils was put on gradually and smoothly to the desired maximum-value by means of a Variac. After demagnetizing the specimen for about 2-3 min. in the peak demagnetizing field, the field gradually decreased to zero. This is done by decreasing the current in the demagnetizing coil smoothly by means of an electrolytic potential divider. This consists of a glass tube 5" in diam. and 1.25 meter long mounted vertically. It has cylindrical electrodes at the ends connected to the output of the Variac. A third electrode of smaller diam. is suspended on a well-insulated wire and is raised smoothly up to the tube by means of a D.C. motor. The tube is filled with a solution of copper sulphate and sulphuric acid, the concentration of which is chosen in such a way that the impedance of the liquid column is roughly equal to that of the tuned solenoid circuit. The circuit is then connected between the moving electrodes and the upper fixed electrodes. This form of alternating demagnetizer has the advantage of decreasing the current gradually, resulting in a smooth decrease of the demagnetizing field.

The main parts of this apparatus are shown in Fig. 2.
Fig. 2. A.C. Demagnetization set up

Fig. 3. Thermal demagnetization apparatus
After demagnetizing the specimen in the desired peak field, the directions of magnetization are measured under the astatic magnetometer. This method is repeated for different alternating peak fields. The original magnetization is considered to be stable if it retains its direction even in large demagnetizing fields (say a few hundred oersteds). The secondary component, if present, is often washed away in low fields, leaving the stable component.

In the present studies, pilot specimens of each sample from each site were subjected to progressive alternating field demagnetization in peak fields of 25, 50, 75, 100, 150, 200 and 300 oersteds, and a certain value of the field was ascertained above which the direction of magnetization became stable.

3.3.3 THERMAL DEMAGNETIZATION APPARATUS

This apparatus designed by Wilson (1938) was constructed at the National Geophysical Research Institute, to study the component of magnetic vector at high temperature.

An important part of this apparatus is a non-magnetic furnace under an astatic magnetometer. It has a carefully designed heating element which was made out of six parallel helices of nichrome wire, wound on quartz tubing with a $\frac{1}{4}$" diameter. Each helix was wired separately with an axial return-wire, and after fixing in position on a mica-sheet, the helix was connected to the adjacent ones in a series by spot-welding, so that the current passes in opposite directions in adjacent helices as shown in Fig. 3a. Then the mica
sheet was bent in the form of a cylinder and enclosed in an asbestos cement cylinder. The mica backing was filled with asbestos wool to prevent direct contact. To the exterior of the furnace a half-inch hole is provided. The rock specimen to be heated is seated on a V-shaped groove which also carries a platinum thermocouple held at the centre by plaster of Paris. This arrangement not only shields the thermocouple from the direct radiation of the heating element, but indicates the exact temperature of the rock specimen. The specimen could be rotated round a horizontal axis with an aluminium screw driver which can be inserted through the hole, for engaging in a slot, made previously on the specimen along the X-direction. Fig. 3b is a schematic diagram of the furnace.

The magnetometer used over the furnace is absolutely unaffected either by the current in the heating element or by the temperature prevailing in the furnace and gives a spot deflection of about 100 cm at 3 meters distance.

3.3.4 EXPERIMENTAL PROCEDURE (THERMAL)

This type of apparatus was used in the present studies to test the stability of NRM and thermal behaviour of rocks. The procedure is as follows.

(i) To test the stability of NRM of a specimen all three components of magnetic vector were measured at different temperature with intervals of about $50^\circ$ to $100^\circ$. The time required for this type of experiments is about two hours.
(ii) For studying the thermal behaviour of a rock, all the components were measured both while heating and cooling the specimen in the present earth field, to complete one specimen. This experiment takes about 4 hours.