DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC MAP OF THE SARATOGA TABLE QUADRANGLE, PENSACOLA MOUNTAINS, ANTARCTICA

By Arthur B. Ford, Dwight L. Schmidt, Walter W. Boyd, Jr., and Willis H. Nelson

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U.S. ANTARCTIC RESEARCH PROGRAM MAP
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GEOLOGIC MAP SYMBOLS
COMMONLY USED ON MAPS OF THE UNITED STATES GEOLOGICAL SURVEY
(Special symbols are shown in explanation)

Contact—Dashed where approximately located; short dashed where inferred; dotted where concealed

Contact—Showing dip; well exposed at triangle

Fault—Dashed where approximately located; short dashed where inferred; dotted where concealed

Fault, showing dip—Ball and bar on downthrown side

Normal fault—Hachured on downthrown side

Fault—Showing relative horizontal movement

Thrust fault—Sawteeth on upper plate

Anticline—Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric anticline—Short arrow indicates steeper limb

Overturned anticline—Showing direction of dip of limbs

Syncline—Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric syncline—Short arrow indicates steeper limb

Overturned syncline—Showing direction of dip of limbs

Monocline—Showing direction of plunge of axis

Minor anticline—Showing plunge of axis

Minor syncline—Showing plunge of axis

Strike and dip of beds—Ball indicates top of beds known from sedimentary structures

Inclined　Horizontal
Vertical　Overturned

Strike and dip of foliation

Inclined　Vertical　Horizontal

Strike and dip of cleavage

Inclined　Vertical　Horizontal

Bearing and plunge of lineation

Inclined　Vertical　Horizontal

Strike and dip of joints

Inclined　Vertical　Horizontal

Note: Planar symbols (strike and dip of beds, foliation or schistosity, and cleavage) may be combined with linear symbols to record data observed at same locality by superimposed symbols at point of observation. Coexisting planar symbols are shown intersecting at point of observation.

Shafts

Vertical　Inclined

Adit, tunnel, or slope

Accessible　Inaccessible

X Prospect

Quarry

Active　Abandoned

Gravel pit

Active　Abandoned

Oil wells

Drilling　Shut-in　Dry hole, abandoned
Gas　Show of gas
Oil　Show of oil

GEOLOGY OF THE SARATOGA TABLE QUADRANGLE PENSACOLA MOUNTAINS, ANTARCTICA

by Arthur B. Ford, Dwight L. Schmidt, Walter W. Boyd, Jr.[1] and Willis H. Nelson

INTRODUCTION

The area that includes the Saratoga Table quadrangle in the Pensacola Mountains was first seen and photographed on January 13, 1956, on a U.S. Navy transpolar flight from McMurdo Sound. Trimetrogon aerial mapping photography of the quadrangle was obtained in January 1958 by the U.S. Air Force.[2] The area was first visited by U.S. Geological Survey parties in the austral summer, 1965 - 66.

Geological, geophysical, and geodetic surveys of the entire map area, as well as over many other parts of the Pensacola Mountains, were made by the U.S. Geological Survey during the 1965 - 66 field season (Huffman and Schmidt, 1966). The surveys used close support of U.S. Army UH - 1B turbine helicopters operating from a base camp in the central Neptune Range where the field party was placed by U.S. Navy LC - 130F (Hercules) aircraft from McMurdo Station. This work completed the geologic mapping of the entire 540-km-long chain of the Pensacola Mountains, a project begun in 1962 - 63 at the south end of the mountains (Schmidt and Ford,1969). Additional geologic studies were made in January 1974 in the vicinity of Mount Lechner (Cameron and Ford, 1974) during investigations of possible ice-runway aircraft landing sites by the U.S. Army Cold Regions Research and Engineering Laboratory (Kovacs and Abele, 1974).

The major geologic feature of this quadrangle is the south end of the Dufek intrusion (Ford and Boyd, 1968), an immense differentiated stratiform mafic igneous body that was discovered in 1957 by an International Geophysical Year (IGY) traverse party visiting Dufek Massif, a northern range of the Pensacola Mountains (Aughenbaugh, 1961; Walker, 1961; Neuburg and others, 1959). Our 1965 - 66 studies showed that the intrusion makes up all of Dufek Massif (Ford and others, 1978) and virtually all of the Forrestal Range. Geophysical surveys show that most of the body is covered by ice sheets adjoining the ranges and that its area is of the order of half that of the Bushveld intrusion of South Africa (Behrendt and others, 1974).

Access to this remote part of the continent is difficult except by ski-equipped aircraft. The ice terrain near the Forrestal Range is generally suitable for ski-plane landings Our two seasons' experience in the area showed summer weather conditions to be mostly fair, but strong winds were common near mountain escarpments. Summer temperatures during our work in the area ranged from about -19°C (-2°F) to -7°C (20°F) and averaged about -12°C (10°F).

Work on the Dufek intrusion in 1965 - 66 was chiefly by A.B. Ford and W.W. Boyd, Jr. and was continued in January 1974 by Ford. Study of the sedimentary country rocks was mainly by D.L. Schmidt and W.H. Nelson.

This report briefly outlines geologic relations and reviews work done in the quadrangle and adjacent regions.

Acknowledgments. – This work was part of the U.S. Antarctic Research Program of the Office of Polar Programs, National Science Foundation. General logistic and fixed-wing aircraft support was provided by the U.S. Navy Air Development Squadron Six. Helicopter support was provided by the U.S. Army Aviation Detachment. We gratefully acknowledge the help of all support personnel, of Jerry Huffman, National Science Foundation, in coordinating the field logistical support, and the assistance by Steven W. Nelson in laboratory studies related to this project.

SYNOPSIS OF GEOLOGIC STUDIES

The map area is near the north end of the Pensacola Mountains, a mountain group that forms part of the transcontinental chain of the Transantarctic Mountains (fig. 1*B*). Principal ranges of the Pensacola Mountains are shown in figure 1*A*.

The principal rock exposures in the map area are units of the Dufek intrusion. This layered igneous body, which is Jurassic in age, intruded moderately to highly deformed Precambrian to Permian sedimentary rocks during the time of emplacement of sills of Ferrar Dolerite throughout the Transantarctic Mountains (Grindley, 1963). The poorly exposed sedimentary country rocks are visible only in small, isolated nunataks in the southern and southwestern parts of the Forrestal Range. Relations between sedimentary formations are inferred to be the same as in the Neptune Range, about 60 km southwest of the Forrestal Range, where the units are much better exposed (Schmidt and others, 1978). General geologic relations between ranges of the Pensacola Mountains are shown on the 1:1,000,000-scale map of Schmidt and Ford (1969). Formal rock-stratigraphic nomenclature for the Dufek intrusion is presented by Ford (1976) and for sedimentary rocks is given by Schmidt and others (1964, 1965), Schmidt and Ford (1969), and Williams (1969). The summary below is drawn largely from these sources.

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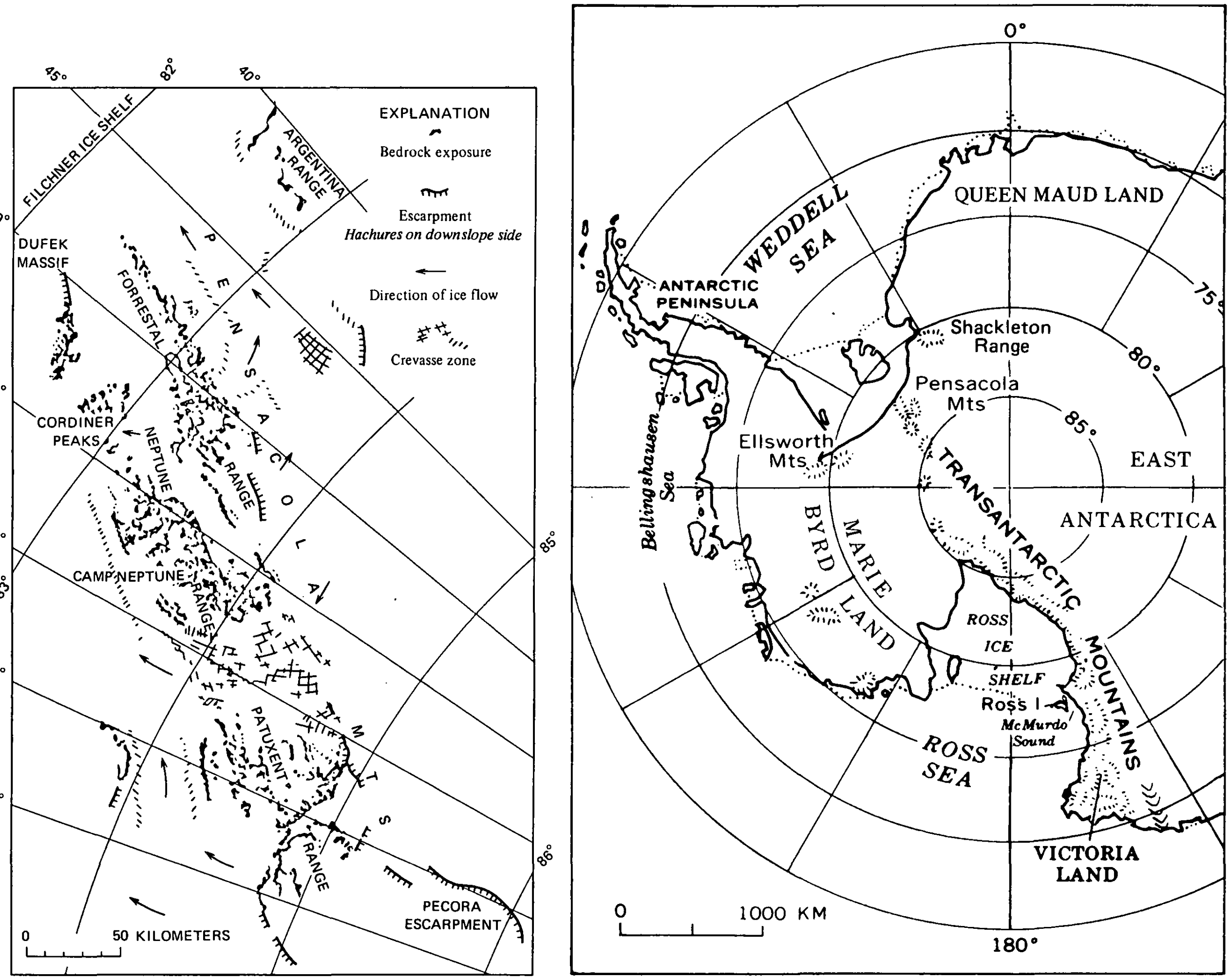
[2] Aerial photographs of the Pensacola Mountains can be ordered from the U.S. Geological Survey, National Center, Reston, Virginia 22092



A *B*

Figure 1. – Index maps. *A*, Major ranges of the Pensacola Mountains and location of Camp Neptune. *B*, Location of Pensacola Mountains in Antarctica.

SEDIMENTARY ROCKS

The sedimentary units exposed in this quadrangle belong chiefly to the youngest of three depositional sequences known to the south and west in the Neptune Range. The sequences in the Neptune Range are clearly seen to be separated by angular unconformities. Fossils are scarce in or absent from most units, but available paleontologic and radiometric age data suggest that ages of the sequences are (1) Precambrian, (2) Middle and Late(?) Cambrian, and (3) Ordovician(?) to Permian. Rocks correlative with the oldest of these sequences are exposed only on small nunataks in the westernmost part of the Saratoga Table quadrangle but are probably much more extensive under the cover of ice. Correlatives of the second sequence are not known but could occur beneath the ice cover. Rocks of the third sequence form the principal nunataks south and west of the Dufek intrusion in this area.

The Patuxent Formation, of late Precambrian age (Schmidt and others, 1978), makes up the oldest sequence and consists in the Neptune Range of at least about 10,000 m of metasubgraywacke and slate locally interbedded with voluminous basaltic and felsic volcanic materials. Radiometric dating (Eastin and Faure, 1972) suggests that some of these volcanic units may be as old as 1,210 m.y. Diabase sills locally intrude the formation. The igneous units of the formation are not known in the Saratoga Table quadrangle. The Patuxent sediments were deposited in a high-energy environment, probably a volcanically active eugeosyncline, as indicated by lithologies and abundant sedimentary structures such as graded bedding, channel features,and sole markings. The Patuxent was widely metamorphosed to the greenschist facies during an orogeny near the end of the Precambrian.

The second sequence, which is not known to occur in and may be absent from the Saratoga Table quadrangle, consists of a fossilferous Middle Cambrian (Palmer and Gatehouse, 1972) limestone and overlying silicic volcanic and clastic sedimentary units that have a composite thickness of at least 700 m. Some of the units are known to thin northward from the southern Neptune Range, and as none are exposed in adjoining areas, they are believed to be absent and are not shown in the cross sections. Accordingly, the single angular unconformity shown is equivalent to the two pre-Devonian angular unconformities that are known below the Neptune Group in the central and southern parts of the Neptune Range.

The third sequence consists, in ascending order, of the Neptune Group, Dover Sandstone, Gale Mudstone, and the Pecora Formation,a succession that is at least 4,000m thick elsewhere in the Pensacola Mountains. The Neith Conglomerate, a coarse, poorly sorted unit at the base of the Neptune Group, is not exposed but probably underlies the Elbow Formation. An upper sandy part of the Neith probably correlates with the Elliott Sandstone, and a lower conglomeratic part with the Brown Ridge Conglomerate, in the type area of the Neptune Group. The Dover Sandstone, which overlies the Neptune Group, is disconformably overlain by the Gale Mudstone, a diamictite of probable continental glacial origin (Schmidt and Williams, 1969; Schmidt and Friedman, 1974). The contact of the Gale with the overlying Pecora Formation is not exposed in the Pensacola Mountains, but the two formations appear to be concordant. Rare diagnostic fossils indicate a Devonian age for the Dover and a Permian age for the Pecora (Schopf, 1968). Depositional environments varied from high energy in late orogenic to early postorogenic time (Ordovician? to Silurian?) during deposition in local basins of the basal part of the Neptune Group, to low energy during Devonian to Permian deposition of later sediments, which probably took place on a slowly subsiding continental shelf or terrestrial plain.

TECTONIC EVENTS

The Pensacola Mountains lie in a mobile belt with a long record of recurrent deformation. The folding of angular unconformities between the three sedimentary sequences shows clearly that episodes of deformation in this region were superimposed. The area lies at or near the intersection of the multiply deformed Transantarctic Mountains fold belt and a younger, probably early Mesozoic, fold belt adjoining the Weddell Sea (Ford, 1972).

Major orogenies in the Pensacola Mountains occurred (1) near the end of the Precambrian; (2) in the early Paleozoic, probably in Late Cambrian and Ordovician time; and (3) in the Triassic. Weak deformation during or after the Jurassic may be indicated by the broad synclinal flexure of the layered Dufek intrusion and by the pervasive system of microshears in the Dufek rocks that parallel a regional fracture pattern (Ford, 1968). The high-angle Enchanted Valley fault zone along the northern base of Dufek Massif may be related to Cenozoic uplift of the Pensacola Mountains.

The two pre-Devonian orogenies in the Pensacola Mountains probably correspond to the Beardmore (580-650 m.y.) and Ross (500-530 m.y.) orogenies, which were widespread in the Transantarctic Mountains (Elliot, 1975). The third major event, locally termed the Weddell orogeny (Ford, 1972), is not recorded by folding in other parts of the Transantarctic Mountains. This event is dated in the Pensacola Mountains as having occurred at some time between the Late Permian and Middle Jurassic. However, the change in paleoslope directions at the beginning of Triassic time in other parts of the Transantarctic Mountains is attributed to uplift in the Pensacola Mountains (Barrett and others, 1972), which thus probably dates the orogeny as Early Triassic. Deformation of about this age is widely recorded elsewhere near the Weddell Sea (Craddock, 1972; Dalziel and Elliot, 1973).

All major folds shown on the map were produced during the Triassic orogeny. Intensity of the folding varies widely in different parts of the Pensacola Mountains. In the Neptune Range, rocks of the third sedimentary sequence in places are folded isoclinally and in other places are little deformed. In the Saratoga Table quadrangle, the folds are open and upright. The rocks are moderately folded about gently plunging or horizontal axes trending about N. 15-30° E. The slight change in axial trends between areas south of Haskill Nunatak and areas to the north may indicate the disruption of N. 30° E. regional trends by emplacement of the Dufek intrusion.

The Patuxent Formation is much more intensely folded than the Paleozoic rocks but is poorly exposed in the map area. In the Neptune Range, axial trends of folds in the Patuxent generally parallel those of the younger rocks.

THE DUFEK INTRUSION

The first work on the Dufek intrusion by Aughenbaugh (1961) and Walker (1961) demonstrated the similarity of the body to other major layered mafic intrusions. The similarity was documented more strongly by our 1965-66 work, which showed the presence of a differentiation trend toward strong iron enrichment in the upper part of the body and a final concentration of a granophyric residuum (Ford and Boyd, 1968; Ford, 1970). The differentiation trend generally follows that of other stratiform complexes summarized by Wager and Brown (1968). Our work has emphasized the sedimentlike nature of most of the layered rocks. Owing to the stratigraphic character of the layered igneous succession, our field studies were carried out largely with techniques used in the study of a stratified sedimentary sequence. In this investigation, 10 partial stratigraphic sections were measured by altimetry and hand leveling in the area of Dufek Massif, and 11 were measured in the Forrestal Range. Those in the Forrestal Range are all in the map area. Most sections within each range are intercorrelated using one or more conspicuous marker layers or horizons. All major areas of outcrop were visited or viewed closely from aircraft. Approximately 1,000 samples collected are representative of all major exposed units. Nearly a third of the samples were oriented for petrofabric and paleomagnetic study.

PETROLOGIC NOMENCLATURE

The layered igneous rocks formed by accumulation of settled crystals in a mush on the floor of a magma chamber. Rocks of this origin are termed "cumulates," and their textures and structures reflect sedimentary processes controlled by gravity, hydraulic parameters of the magma, and the presence or absence of currents (Jackson, 1971). Following usage in sedimentary petrology, which distinguishes detrital grains from cement, the cumulus (detrital) phases form the framework of the rock, and the postcumulus (cement) phases are primary materials that crystallized in places they now occupy.

Cumulates are named by prefixing names of settled minerals in order of decreasing abundance (Jackson, 1967, p. 23). The principal cumulus phases in the Dufek intrusion are plagioclase, pyroxenes in the series augite-ferroaugite, pyroxenes in the series bronzite-inverted pigeonite, and opaque oxides. Preliminary results of studies in progress on the chemistry and mineralogy of opaque oxides indicate that the most common phases are titaniferous magnetite and ferrian ilmenite in composite grains that probably represent unmixing of original homogeneous titaniferous magnetite (Himmelberg and Ford, 1975;1977). For brevity, the opaque oxides are referred to simply as magnetite. Phases that are cumulus in some rocks are postcumulus in others. Quartz and K-feldspar are known to be only postcumulus and so are not included in the cumulate terminology. Two pyroxene-plagioclase cumulate is the predominant lithology in the lower part of the intrusion, and two pyroxene-plagioclase-magnetite cumulate predominates in the upper part.

Rock names used in the map explanation and text are of two types based on (1) total mode of the rock and (2) types and proportions of cumulus minerals. In our field studies, rocks were mapped on the basis of total mode, in which cumulus and postcumulus minerals are not distinguished. The map units are given formal rock-stratigraphic names using standard noncumulate igneous rock nomenclature. The cumulate terminology of Jackson (1967, 1971) is used, however, in the explanation and text for description of the rocks. Where proportions of cumulus minerals are not known, or not otherwise indicated, conventional names are prefixed, as in "gabbroic cumulate" or "anorthositic cumulate."

STRATIGRAPHIC NOMENCLATURE

The rock-stratigraphic nomenclature and stratigraphy of the intrusion are discussed by Ford (1976) and are shown in figure 2. The layered succession of rocks is incompletely exposed and is estimated on the basis of structure and geophysical evidence to be of the order of 8 - 9 km thick. A lower part of the body is exposed in Dufek Massif. The composite section of this part, about 1,800 m thick, is referred to as the "Dufek Massif section." The upper part of the body is exposed in the Forrestal Range. The composite section of this part, about 1,700 m thick, is referred to as the "Forrestal Range section." An ice-covered interval, termed the "Sallee Snowfield section," between the two exposed-rock sections, is estimated to be 2 - 3 km thick. Geophysical studies by Behrendt and others (1974) suggest that an unexposed basal section is 1.8 - 3.5 km thick. An unknown but probably small thickness of rock was eroded from the upper part of the body.

Fine- to coarse-grained gabbro near the contact and dike rocks ranging from aplite to gabbroic pegmatite are the principal nonstratified rocks of the intrusion. The contact gabbro is of noncumulus origin and probably forms an envelope around the layered sequence. It is exposed at only a single locality near Mount Lechner in the southern Forrestal Range.

All the stratified rocks are included in the Forrestal Gabbro Group, which is divided into four formations, from base to top, the Walker Anorthosite, Aughenbaugh Gabbro, Saratoga Gabbro, and Lexington Granophyre. Distinctive, mappable units of the Aughenbaugh and Saratoga are recognized as members. Most members consist of one or more mineral-graded cumulate layers. Two members of the Saratoga are characterized by an abundance of cognate inclusions composed of noncumulus anorthosite and leucogabbro. The chief lithologic difference between the Aughenbaugh and Saratoga is the much greater abundance of cumulus magnetite in the Saratoga. Other mineralogic differences are discussed subsequently.

MINERAL DISTRIBUTION AND COMPOSITION

The Forrestal Gabbro Group contains highly variable proportions of cumulus minerals. The stratigraphic distribution of these minerals and of postcumulus minerals is shown in figure 2. Cumulates of gabbroic composition generally consist of subequal amounts of plagioclase and pyroxene. Magnetite is a chief modal variant occuring in only minor amounts near the top of the Aughenbaugh Gabbro and as a major constituent throughout the Saratoga Gabbro. In many thin layers and lenses in the Saratoga, it is the only or the greatly predominant mineral, commonly at the base of thicker mineral-graded layers. The upward stratigraphic increase in amounts of magnetite in the intrusion as a whole results in an overall upward increase in average rock density (Ford and Nelson, 1972) and in great differences in aeromagnetic intensities measured over the two ranges (Behrendt and others, 1974). Layers in which cumulus plagioclase is concentrated occur throughout the intrusion, as in the Walker Anorthosite, Spear Anorthosite Member, and Stephens Anorthosite Member; whereas layers in which cumulus pyroxene is concentrated occur only in the Dufek Massif section, as in the Neuburg[3] and Frost Pyroxenite Members. Most of these layers are of mineral-graded type. Apatite is a common though minor cumulus phase in the highest cumulates of the Saratoga Gabbro and is a noncumulus constituent of the Lexington Granophyre. Quartz and K-feldspar are minor postcumulus minerals in the upper part of the Saratoga and are dominant constituents of the Lexington.

The chemistry of bulk rocks and of individual mineral phases shows progressive stratigraphic changes generally similar to those of other stratiform mafic intrusions described by Wager and Brown (1968). As determined by preliminary optical and X-ray studies, plagioclase compositions range from about An_{80-85} in anorthositic cumulates near the base of the Dufek Massif section to about

[3] This name, derived from Neuburg Peak, was incorrectly spelled "Neuberg" in previous reports (Ford, 1976; Himmelberg and Ford, 1976)

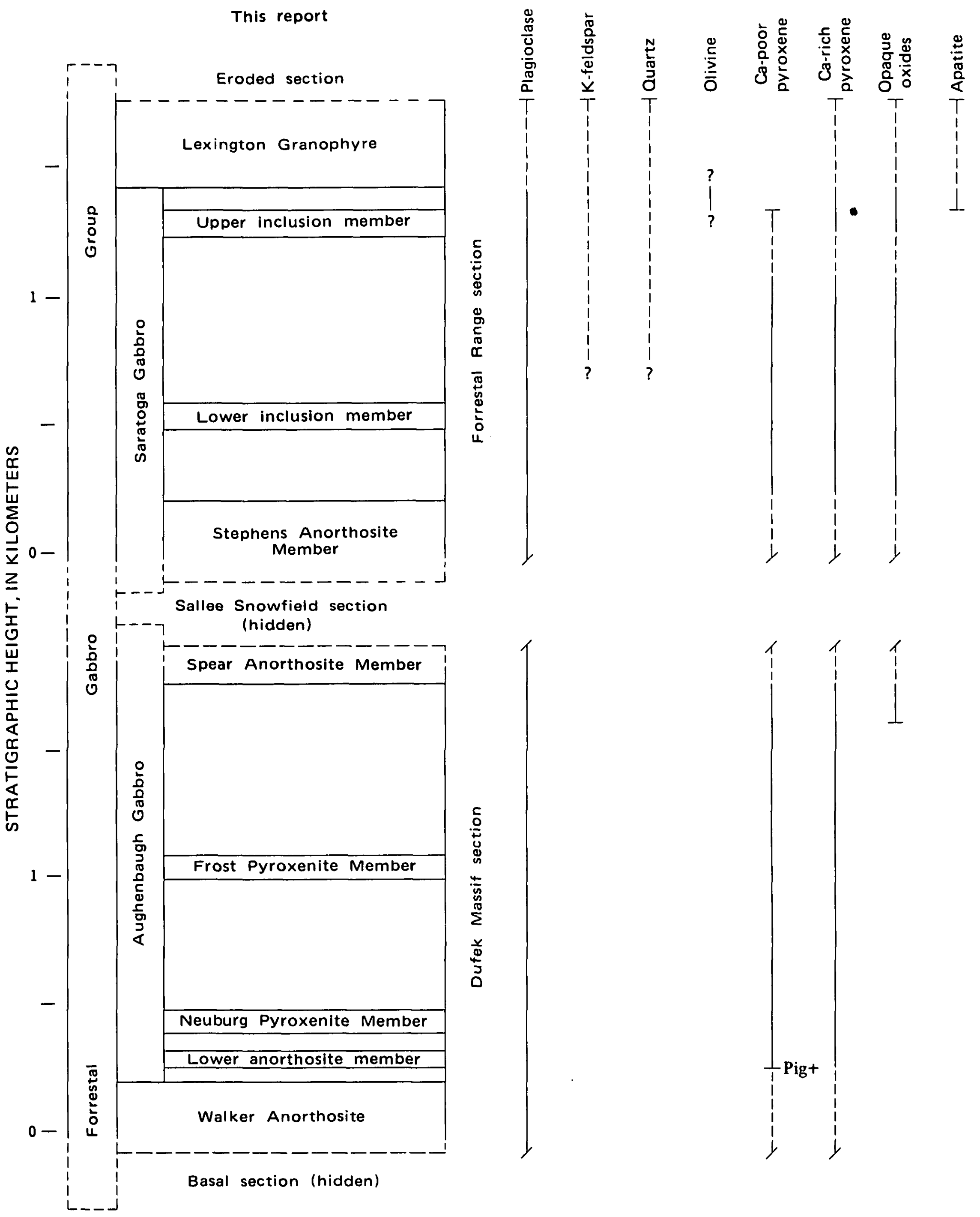


Figure 2 – Rock-stratigraphic nomenclature of the Dufek intrusion and distribution of minerals. Solid vertical lines, cumulus minerals; dashed lines, noncumulus minerals (in granophyre) and postcumulus minerals. Pig+, lowest occurrence of inverted cumulus pigeonite. After Ford (1976) and Himmelberg and Ford (1976)

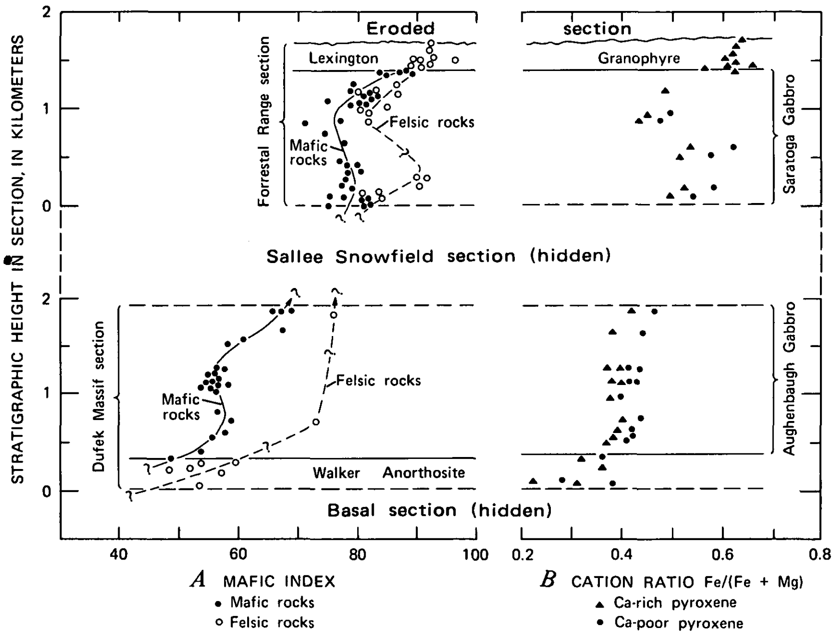


Figure 3 – Stratigraphic variations in chemical composition in the Dufek intrusion. *A*, Mafic index, ($FeO + Fe_2O_3$) x 100/($FeO + Fe_2O_3 + MgO$), of whole rocks (after Ford, 1970). *B*, Cation ratio, Fe/(Fe + Mg), of the two pyroxene series (after Himmelberg and Ford, 1976).

An_{45-55} in gabbroic rocks and granophyre near the top of the Forrestal Range section (Ford and Boyd, 1968). Electron microprobe analyses show that Ca-rich cumulus pyroxenes in the series augite-ferroaugite range from $Ca_{36.4}Mg_{48.7}Fe_{14.9}$ to $Ca_{30.0}Mg_{23.5}Fe_{46.5}$, and that Ca-poor cumulus pyroxenes in the series bronzite-inverted pigeonite range from $Ca_{3.5}Mg_{69.1}Fe_{27.4}$ to $Ca_{11.4}Mg_{34.0}Fe_{54.6}$ (Himmelberg and Ford, 1973, 1976). The upward stratigraphic increase in the ratio Fe/(Fe + Mg) in both pyroxene series and the increase in modal magnetite are reflected in the general upward increase in the mafic index of bulk-rock compositions (fig. 3). Although major-element contents of the oxide minerals show no regular variation with height, the minor elements vanadium and aluminum in ilmenomagnetites generally decrease with height and thus are useful indicators of fractionation trends during the stage of oxide-mineral crystallization (Himmelberg and Ford, 1977).

DIKE ROCKS

Felsic dikes with wide range in textural and chemical characteristics are the only dikes observed in the map area. Mafic dikes similar to those in the Cordiner Peaks (Ford, 1974; Ford and others, 1978) were not found. The dikes are all within the Dufek intrusion except for two thin aplite and pegmatite dikes less than 10 cm thick that cut the Pecora Formation on Grob Ridge. Within the intrusion they occur at many stratigraphic levels. Dike rocks are mainly felsite, aplite, and felsic pegmatite and include alaskite, leucogabbro, gabbroic pegmatite, and granophyre. Zoning occurs locally. The dikes are vertical or subvertical and in places can be seen to pinch out downward. Thicknesses of different dikes range from a few millimeters to several meters. Compositions of the dikes seem to show changes related to stratigraphy and compositional changes of cumulate-host rocks, which suggests that they formed by the filling of fractures with late intercumulus liquids from local sources at various stages during consolidation of the intrusion (Ford, 1970). Granophyric dikes high in the intrusion may be related to development of the Lexington Granophyre at the end stage of differentiation.

REGIONAL CORRELATION

Sedimentary formations in the Pensacola Mountains are apparently correlatable for great distances in the Transantarctic Mountains and probably in the Ellsworth Mountains. All sedimentary units in the Saratoga Table quadrangle probably are part of the Beacon Supergroup, a thick platform sequence of mainly arenaceous rocks ranging in age from Devonian or older to Jurassic in the Ross Sea region (Barrett and others, 1972). Sedimentation in the Pensacola Mountains area apparently terminated in the Permian, however, owing to orogenic uplift. The Neptune Group and Dover Sandstone probably correlate with the Taylor Group near the Ross Sea. The Dover may also correlate with the Crashsite Quartzite in the Ellsworth Mountains (Schopf, 1969). The Gale Mudstone and Pecora Formation probably correlate with the lower part of the Victoria Group near the Ross Sea. Late Paleozoic glaciation was widespread in Antarctica, but dating is poor in the general absence of diagnostic fossils. The Gale Mudstone probably also correlates approximately with the Darwin Tillite, Buckeye Tillite, and Pagoda Formation elsewhere in the Transantarctic Mountains (Barrett and others, 1972) and with the Whiteout Conglomerate in the Ellsworth Mountains (Schopf, 1969). Units in the Pensacola Mountains probably also have equivalents in the Shackleton Range (Stephenson, 1966; Clarkson, 1972) and possibly in western Queen Maud Land (Juckes, 1972).

The Patuxent Formation, consisting of metasedimentary rocks of pre-Beacon age, probably is also widely correlatable, but paleontologic dating is poor, and interpretation of radiometric ages (Eastin and Faure, 1972) is complicated by resetting.

Basaltic igneous activity, both intrusive and extrusive, was widespread in Antarctica in mid-Mesozoic time. The Dufek intrusion correlates approximately with the Ferrar Group of Grindley (1963), which in the Ross Sea sector of the Transantarctic Mountains includes the Ferrar Dolerite and the Kirkpatrick Basalt. Similar mafic intrusive rocks of this age are reported from the Shackleton Range area (Stephenson, 1966) and western Queen Maud Land (Juckes, 1972). The Dufek intrusion is by far the largest single differentiated intrusive body of Ferrar age known in Antarctica. However, smaller layered intrusions are known in the Ferrar Group (Gunn, 1963; Grapes and Reid, 1971).

SYNOPSIS OF GEOPHYSICAL STUDIES

GRAVITY AND AEROMAGNETIC DATA

Results of gravity and aeromagnetic surveys in the Pensacola Mountains are discussed by Behrendt and others (1974). The geologic map of the Saratoga Table quadrangle should be used in conjunction with the aeromagnetic intensity and simple Bouguer gravity maps of Behrendt and others (1973), which are also at 1:250,000 scale, as an aid in interpreting the geology of the extensive ice-covered regions. The location of the contact of the Dufek intrusion on this sheet is based largely on the geophysical anomaly maps.

A broad, regional Bouguer gravity gradient crosses the Pensacola Mountains. Values range from 82 mgal in the northwest, over Ronne Ice Shelf, to -90 mgal in the northern Neptune Range. Values over the mapped extent of the Dufek intrusion range from 40 mgal in the northwest to -60 mgal in the southeast. Theoretical models based on the gravity data suggest either crustal thinning northwestward across the west front of the Pensacola Mountains, or the presence of a steep, faultlike step at the crust-mantle interface along this front.

The mass effect of the Dufek intrusion is superimposed on and distorts the regional gravity gradient. The exact gravity effect of the intrusion cannot be calculated from available data, but the maximum effect is estimated to be about 85 mgal. Assuming a reasonable range of density contrast of 0.27 - 0.33 g/cm^3, this corresponds to about 8.8 - 6.2 km for total thickness of the Dufek intrusion, according to Behrendt and others (1974, p. 13). Using gravity data from the southwest end of Dufek Massif, where the lowest part of the body is exposed, and an assumed density contrast of 0.27 g/cm^3, the basal unexposed part of the intrusion is estimated to be 1.8 - 3.5 km thick.

Aeromagnetic anomalies of nearly 2,000 gammas, from peak to trough, are associated with the Dufek intrusion. In the Saratoga Table quadrangle, the maximum magnetic intensity of 1,100 gammas occurs near the southeast edge of Lexington Table about 3 km southwest of Mount Mann. Minimum intensities of -200 to -500 gammas occur in a narrow belt from Henderson Bluff to near Mathis Spur. The high magnetic anomalies, accordingly, are clearly associated with the magnetite-bearing to magnetite-rich gabbroic cumulates of the upper part of the intrusion.

The aeromagnetic anomalies extend northward to the edge of the surveyed region in the Davis Valley quadrangle; thus the full extent of the body is not known. The magnetic survey indicates that the intrusion is at least 24,000 km^2 in area, and gravity data suggest that it has an additional area of 10,000 km^2 (Behrendt and others, 1974). Behrendt and others (1973) believe that the areas of 200-gamma magnetic intensity and high gravity anomaly shown southeast of the Forrestal Range indicate a possible buried extension of the body. If their interpretation is correct, the intrusion would extend much farther southeastward than indicated on the geologic map and cross sections, and the outline of the body would be much more irregular than here inferred, as the sedimentary country rocks from Ray Nunatak to Coal Rock would form a deep embayment into the body. Although this is possible, especially if concealed faults are present, we believe that the geophysical anomalies are more likely related to a different body of mafic rock. Because of this uncertainty, both alternative contacts in this ice-covered region are shown on the map.

PALEOMAGNETIC DATA

Paleomagnetic properties of rocks of the Dufek intrusion are discussed by Beck and others (1968), Griffin (1969), Beck and Griffin (1971) and Beck (1972). Intensity of natural remanent magnetization and magnetic susceptibility generally increase with height in the intrusion. Both normal and reversed polarities are present and may have resulted from either a self-reversal or a geomagnetic field-reversal mechanism. The paleomagnetic pole position for the body is at lat 56.5° S., long 168° W., near poles reported for the Jurassic Ferrar Dolerite from elsewhere in the Transantarctic Mountains.

The paleomagnetic studies reported by Beck and Schmidt (1971) show that regional heating apparently associated with the Triassic Weddell orogeny in the Pensacola Mountains resulted in the resetting of remanent magnetization directions of Cambrian volcanic rocks in the southern Neptune Range.

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