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APPRAISAL OF IRON DEPOSITS IN SOUTHERN AND WESTERN TURKEY

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ABSTRACT

Between May 20 and June 17, 1969, previously known iron deposits were examined widely at eight separate localities in western Turkey. The object of the examinations was to learn the nature, geologic setting, and approximate size of each deposit, to review prior estimates of size, and possibly recommend additional exploratory work. The full extent of each deposit is poorly known at the present time, so recommended additional work entails drilling, digging trenches or pits, geologic mapping or, combinations of these activities.

On Çaldagi Mountain an area of about 1 sq km is capped by brecciated chert under which may be a continuous zone of mixed iron oxides and chert fragments. The thickness of the ferruginous zone is poorly known but is as much as 12 meters in at least one place. The ferruginous material and chert appear to have formed by the weathering of serpentine, but this concept needs further testing. Drilling is recommended to determine the grade, thickness, and extent of the ferruginous zone

beneath the cherty cap. Inasmuch as mining by hand sorting is in progress, part of the deposit can be considered to be marginally in the category of iron reserves.

The Keçeborlu iron deposit consists of earthy to slightly compacted hematite and limonite mixed with small chert fragments. The surface area underlain by ferruginous rock is about 5,000 to 7,500 sq meters. The maximum known thickness of the deposit is about 7 meters. Iron appears to have been concentrated by weathering and oxidation of cherty limestone. The deposit is probably either a remnant of a once more extensive weathered cap, or a sink hole filling. The Keçeborlu area warrants a low priority for further exploration, but one drill hole is recommended to test the thickness of the deposit.

The iron deposits at Mellec are layered and vein magnetite replacements of limestone. The six known deposits are discontinuous. No additional work is recommended.

The Gilindire iron deposit consists of irregular concentrations of pisolitic and earthy hematite and limonite along an unconformity or disconformity between two groups of limestone. The ferruginous zone is incompletely known around the rim of the large Gilindire syncline. Data from trenches 5 to 6 km around the syncline--about ¼ the possible length of the ferruginous zone--provide the main knowledge about the size and grade of ferruginous lenses.

The ferruginous lenses range in thickness from a fraction of a meter to about 5 meters, but appear to average 1 meter or less, and range in grade from about 10 to 37 percent iron. No additional exploration work is recommended at Gilindire.

The Büyükeceli deposit consists of veinlike masses of earthy and compact hematite and limonite cutting fresh limestone. The veins apparently originally contained siderite which has been weathered and converted to iron oxide. Further exploration by drilling is recommended at such time as other largest deposits are able to be brought into the development stage in the Mediterranean coastal area of Turkey.

The iron deposits overlooking Payas on the Gulf of Iskenderun are in one or more layers along the west-facing front of the Amanus Mountain Range, between beds of gently to moderately east-dipping limestone. Isolated exposures may represent a once-continuous ferruginous bed that has been blockfaulted and intruded by serpentine. The ferruginous bed (or beds) is 20-30 meters thick and consists of a mixture of very fine grained hematite and claylike material. Iron content ranges from 20 to 40 percent and alumina averages about 15 percent. Available data on distribution are scant but suggest that one ferruginous bed may be 1-2 kilometers long, 500 meters wide, and 20 meters thick.

The potentially large size of the Payas deposits warrants an early co-ordinated program of drilling and beneficiation testing.

An iron deposit was examined on a conspicuous limestone ridge in the Syrian graben east of the Amanus Mountain Range, about 15 km south-east of the town of Kirikhan. Iron is present mainly as earthy to somewhat compacted hematite. Rounded and frosted sand grains are common in the ferruginous material. Test pits indicate abrupt local relief between the ferruginous body and surrounding limestone. The ferruginous rock probably formed either by the filling or collapse of a sink hole or cavern, or as a stream deposit along a valley bordered by low limestone cliffs. The deposit covers an area of about 1/10 sq km. A possible second deposit of similar material was found on the same limestone ridge. An early program of drilling and test pitting is recommended for the deposit and possible second deposit to test their contents, thickness, and full extent.

Two adjacent magnetite deposits were examined near Ulukisla on the north side of the Taurus Mountain Range south of Nigde. The deposits, in a contact zone between felsic igneous rock and limestone, formed by the irregular replacement of the limestone. Blocks of limestone and magnetite-bearing zones commonly are truncated by the igneous rock. Indicated resources are 180,000 tons of magnetite. The Ulukisla area warrants only a low priority for exploration. Any future drilling and magnetic surveying should be guided by the results of detailed geologic mapping, which should be the first step in exploration of the area.

INTRODUCTION

Between May 20 and June 17, 1969, iron deposits were examined at widely separated localities in the western half of Turkey, as far east as the vicinity of the Syrian border east of the Gulf of Iskenderun. The deposits are at Çaldagi Mountain about 50 km east of Izmir; at Keçeborlu in the Isparta area; at Melleç, Gillindire, and Büyükeceli along the Mediterranean coast between points about 25 km west and 100 km east of the town of Anamur; in the Amanus Range near Payas overlooking the Gulf of Iskenderun; near Kirikhan in the Syrian graben east of the Amanus Range; and at Ulukisla on the north side of the Taurus Range not far south of Nigde (see fig. 1). Time spent examining the deposits ranged from about 2 hours to several days, depending on the extent of each. The work was done as part of the mineral exploration program undertaken cooperatively by the Maden Tetkik ve Arama Institüsü (MTA) and the U. S. Geological Survey (USGS) under the auspices of the Government of Turkey and the Agency for International Development, U. S. Department of State (USAID).

The deposits of iron had all been opened by test pits, trenches, or adits prior to our visits, and three have been the subject of fairly detailed studies and reports by the MTA or private interests. Reports on all known prior work are available in MTA files. In each case the objectives of our visit were to determine the nature and geologic setting of the deposit, and its approximate size, to review prior estimates

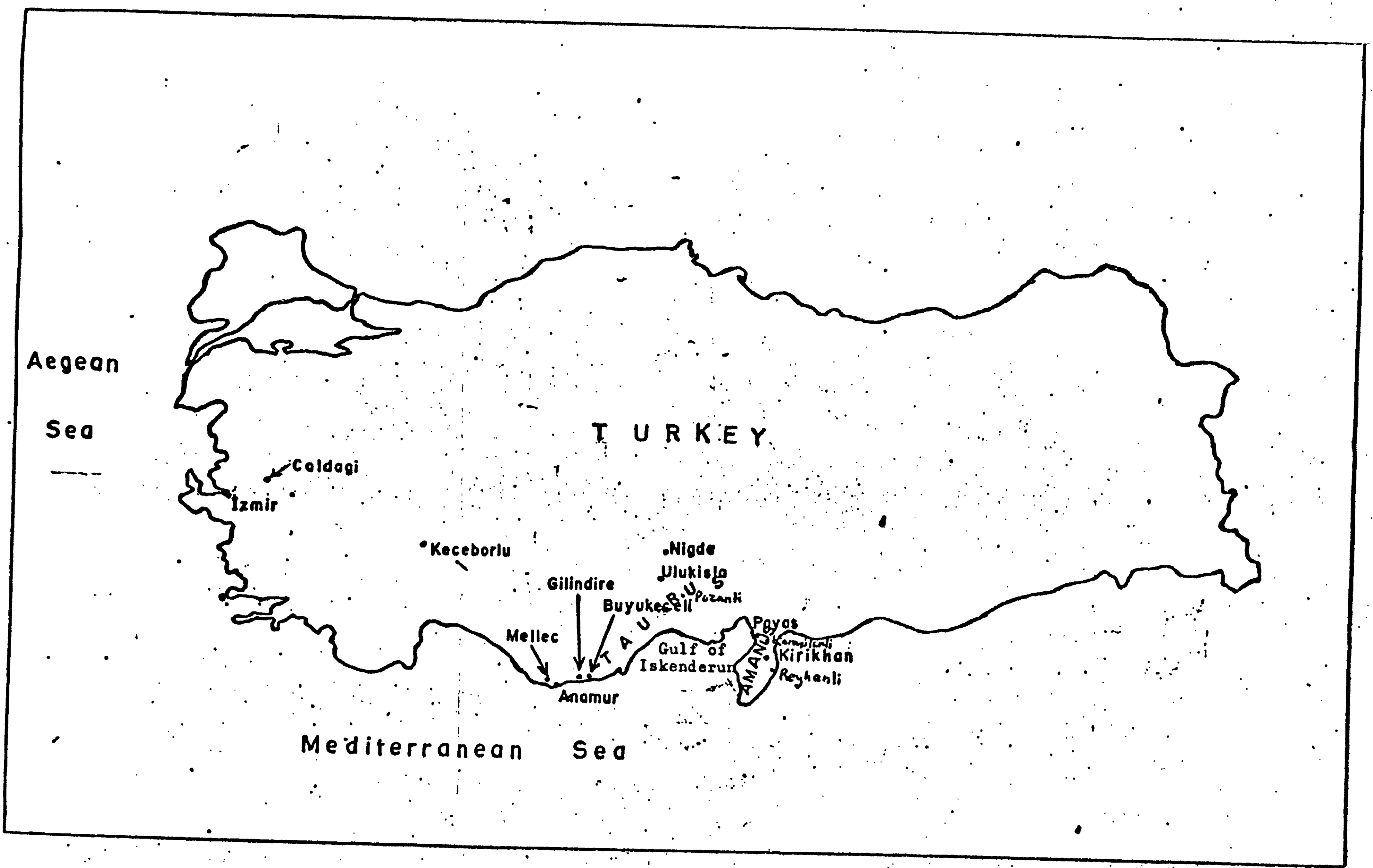


Figure 1. Outline map of Turkey showing locations of iron deposits examined, May 20–June 17, 1969

of size, and where warranted to recommend additional work that would provide information about size and grade of the deposit. Because the full extent of each deposit is poorly known at the present time, the recommended additional work entails drilling, digging of trenches or pits, geologic mapping, or combinations of these activities. For most of the deposits, such exploratory work must go hand in hand with laboratory testing of the ferruginous rock to determine methods of extracting the iron content economically, if the deposit is to be fully evaluated.

General statement about appraisals

The appraisals of the iron described on the following pages are based on several kinds of evidence. The tonnages of iron minerals that are visible or otherwise known (such as by drilling) are combined with tonnages of hidden iron minerals that can be reasonably inferred to be present in each locality.

Several guiding principles have been followed:

(1) Any concentration of iron in the earth's crust is an unusual natural phenomenon and cannot be taken for granted. Therefore, the opposite, the lack of concentration of iron, is taken for granted that is --unless iron (a) can be seen to be concentrated, (b) is known to be present from drilling or magnetic surveying data, or (c) can reasonably be inferred to extend into places where it is neither seen nor otherwise known, it is assumed to be absent. In inferring hidden iron mineral concentrations, it is assumed that the grade and thickness are of the same order of magnitude as

those of visible and known concentrations in the same zone. If visible and known deposits in a given locality are discontinuous, no hidden iron is assumed to be present except as direct subsurface continuations of the known iron bodies. Assumed subsurface continuations of known iron bodies are given dimensions no greater than the dimensions of the known body. Iron-rich lenses (known to be discontinuous) at a given horizon are evaluated as the separate bodies that they are, and are not connected together to form a continuous iron-bearing layer for purposes of tonnage evaluation.

(2) If a body of iron ore is seen to be discontinuous, it is assumed to be a lens, and not part of a larger layer that has been disrupted by faulting unless (a) other objective evidence of faulting is present (b) a continuation of the iron-rich layer is known on the other side of the supposed fault. To use the known termination of an iron-rich layer alone as evidence of faulting and as justification for assuming that the layer continues beyond the fault is the same as reasoning that because the iron-rich bed is seen to end, it must continue.

(3) The thickness of iron-rich rock used for computing tonnage is only the measured or estimated thickness of the concentration of iron mineral, and does not include iron-poor or iron-free rock between the iron-rich layers. At Melleç, for example, magnetite-rich rock ranges from about 1/3 meters to 2 meters in thickness, and is distributed through 3 to 10 meters of limestone, respectively. The 1/3 to 2-meters values are used for tonnage calculations rather than the 3 to 10-meters values.

DESCRIPTION OF IRON DEPOSITS

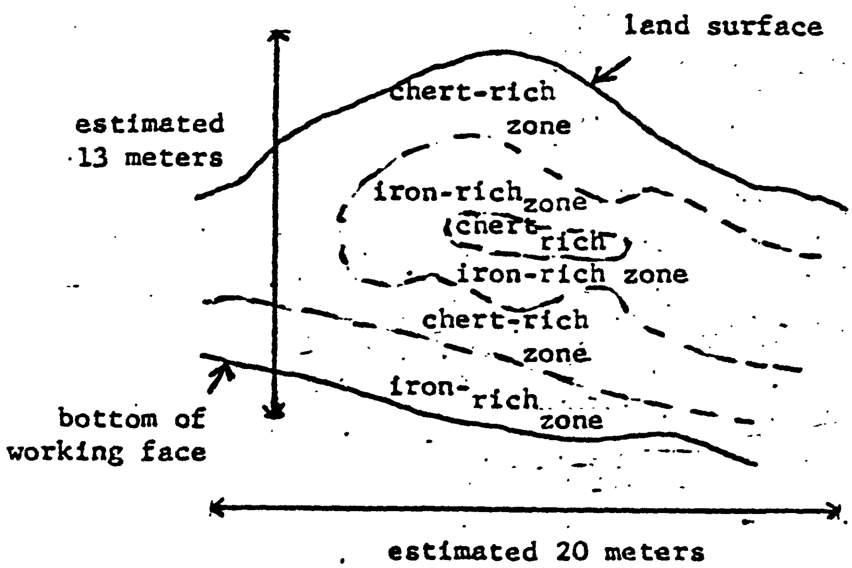
Çaldagi Mountain

(Izmir k-19 c_1 and Izmir k-19 c_4 sheets)

A concentration of hematite iron oxide was examined on Çaldagi Mountain, about 50 km east of Izmir. Major rocks on the mountain are limestone and serpentine. The serpentine apparently developed from an ultramafic igneous rock that had intruded the limestone. A probable xenolith of limestone was seen in the serpentine at one place.

Direct knowledge of the iron deposit was gained from exposures in several pits and open cuts in the iron-rich zone to depths of 1 to about 13 meters below the land surface. None of the artificial openings shows the bottom of the deposit, but serpentine, or altered rock probably derived from serpentine, was seen in hillsides close below the lowest part of three of the cuts. The deepest pit was mined at the time of our visit; it produces about 30 tons a day. Other cuts expose no more than 2 to 3 meters of the ferruginous zone. In two openings 2 and 3 meters deep, laminar concentrations of earthy hematite and limonite 1 to 2-3/4 meters thick in which the layers lie parallel to the land surface, overlie compact hematite of unknown thickness. The compact hematite is probably not more than 3 to 4 meters thick judging by the nearness of serpentine downslope. At one of these cuts, the compact hematite is cut by veins of colorless coarsely crystalline carbonate. The iron oxides are associated with abundant cherty quartz.

The cherty quartz is mainly angular pieces that are concentrated in irregular areas or zones, ½ meter or less in diameter to several meters (see sketch below). These zones are irregularly interspersed with iron-rich zones having similar dimensions. The proportion of chert to iron oxide is probably at least 60:40, or greater. The iron oxide-cherty quartz mixture appears to form a layer not more than 10 to 15 meters thick above serpentine on the tops and upper slopes of ridges adjoining the higher part of Caldagi Mountain on the south and southeast. The iron oxide-cherty quartz mixture in turn is capped by a compact layer of breccia-like chert, ½ to 3 meters thick at land surface. The chert cap covers an area of about 1 sq km. Several widely separated artificial openings through the chert cap reveal concentrations of iron oxide beneath, so it seems likely that the area of iron mineral concentration coincides with the area overlain by the chert cap. Drilling through the deposit into the underlying rock is needed to verify this conclusion, as well as to determine more accurately the average thickness of the iron-rich zone and the average ratio of iron to chert in that zone.



Diagrammatic sketch showing distribution of chert-rich and iron-rich areas in part of mining face at largest pit in Caldagi deposit.

The origin of the deposit at Çaldagi Mountain is somewhat of a puzzle. The spatial relationships strongly suggest that the iron oxide and cherty quartz evolved from the serpentine and were concentrated by weathering and the downward movement of ground water from the land surface as magnesia, principally, was removed in solution. The chert cap fits this concept well as representing an end stage in which even iron oxide has been moved downward from the land surface to leave a residual concentration of chert held together by silica cement. However, the normally very small proportion of iron that substitutes isomorphously for magnesium in serpentine minerals makes uncertain the availability of enough iron in the serpentine at Çaldagi to produce the concentrations of iron there. Large low-grade iron deposits, formed by the weathering of serpentine, have been known for many years in eastern Cuba, but there silica generally has been largely removed during the weathering, probably because of the tropical climate (Spencer, 1907; Weld, 1909; Leith and Mead, 1911, 1916). In any case, the Cuban serpentine has clearly been able to give rise to concentrations of iron upon weathering. The origin of the deposit at Çaldagi Mountain might be determined by analyses of serpentine minerals to determine Fe:Mg ratios and Ni-Cr content, and by core drilling through the iron deposit into the rock beneath to learn the nature of the transition. Knowing the origin of this deposit could be economically significant because if the deposit did form by the weathering of iron-bearing serpentine, similar serpentine bodies could be sought and prospected for surficially concentrated iron deposits.

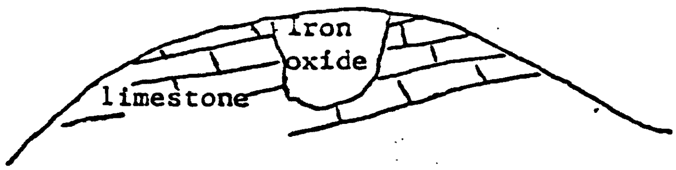
Keçeborlu

(Isparta-M24-b_1 sheet)

An iron mineral locality was examined on the upper slope of a hill near the town of Keçeborlu, about 30 km northwest of Isparta. The ferruginous material is exposed in several shafts and pits, all of which bottom in ferruginous material at depth of 2 to 7 meters. Ferruginous material is not concentrated enough or otherwise indicated well enough at the land surface to map the edge of the deposit accurately without additional artificial openings. The deposit appears to be roughly oval in plan, and to have maximum possible dimensions of about 75 by 150 meters. Outcrops adjacent to the area of ferruginous rock are cherty limestone. The ferruginous material consists of mixed earthy to slightly compacted hematite and limonite. Small angular pieces of chert are common throughout the ferruginous material. Different degrees of weathering, oxidation, and the replacement of limestone by iron oxide adjacent to the deposit suggest derivation of the concentrations of iron oxide by extreme weathering and oxidation of limestone. The resemblance of small angular pieces of chert in the carbonate rock to those in the ferruginous material also indicates derivation of the iron oxide from the limestone.

The depth of the deposit is unknown. Concentrations of iron oxide are not present on the steep hillsides 10 meters lower than the top of the deposit, so the deposit is less than 10 meters thick, or, if thicker, does not extend laterally as far as the sides of the hill. If the latter is true, the deposit may occupy a sink hole or may have formed by the collapse of weathered limestone into a cavern, and could be more than

10 meters deep without being present on the surrounding hill slopes. (see sketch below).



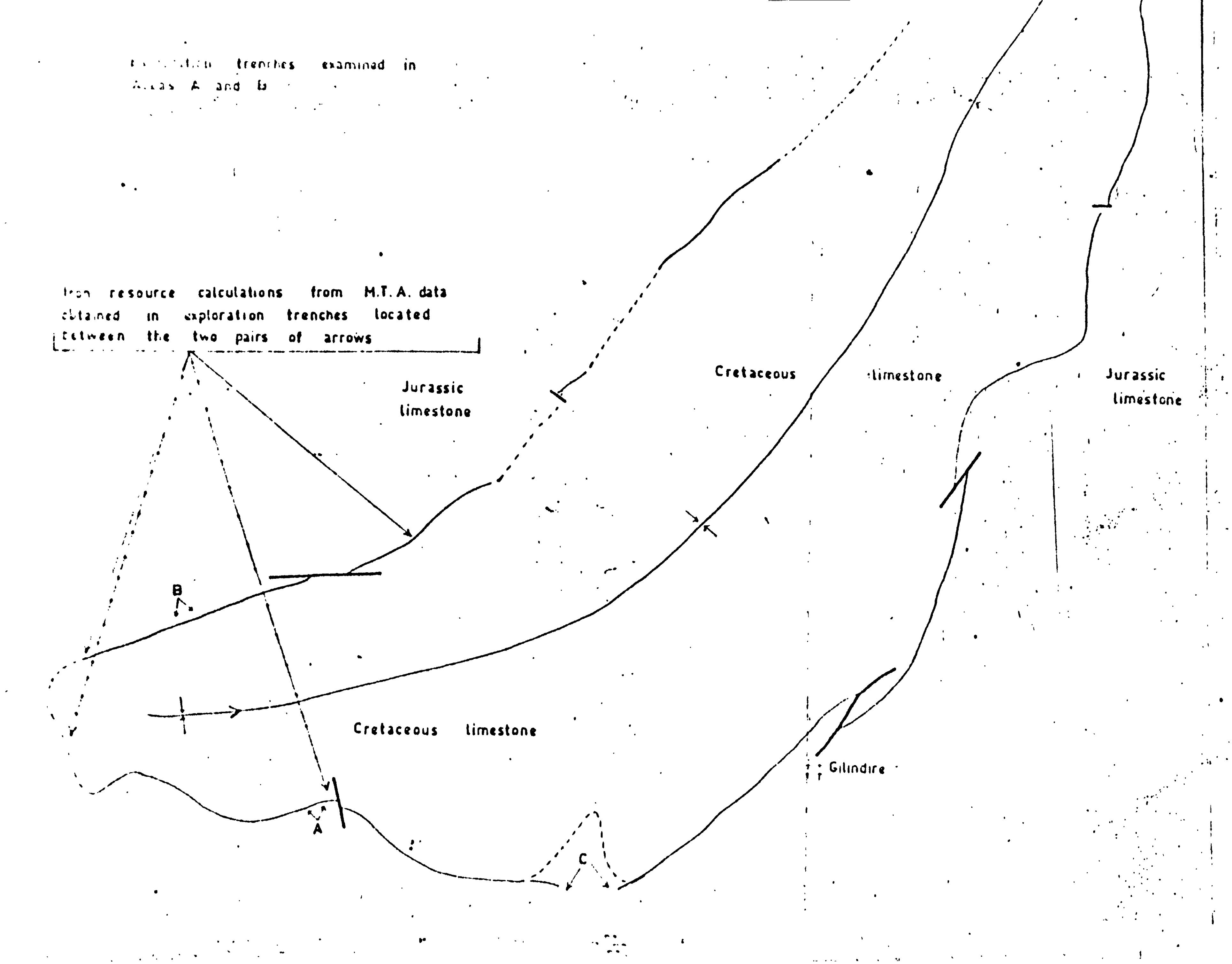
Diagrammatic section showing possible origin as sink-hole filling.

Melleç

(Alanya-P 29-d_3 sheet)

Six deposits of iron minerals were examined near Melleç (localities A-F, fig. 2).

Layered and vein magnetite replacements of limestone were seen at localities A, B, C, D, and E. An overgrown and partly caved-in trench or adit at locality F reportedly explored a magnetite locality, but magnetite was not seen there. The magnetite concentrations at localities A to E are discontinuous. Although other concentrations of magnetite may exist in areas between these localities, their possible locations and dimensions apparently are unknown and so cannot form a basis for calculations of tonnage of iron reserves or resources.


Exploration trenches examined in
Areas A and B
Iron resource calculations from M.T.A. data
obtained in exploration trenches located
between the two pairs of arrows
Jurassic limestone
Cretaceous limestone
Jurassic limestone
Cretaceous limestone
Gilindire
A
B
C

Locality A

Most of the host rock is partly altered limestone and is pale yellow brown. Magnetite layers are sometimes conformable but also cut across the bedding of the limestone. Magnetite layers and clusters of layers range in thickness from about 1 mm to 5 cm, and most of them dip steeply. Locally a little pyrite is associated with the magnetite. The thickest concentration (50 cm) of magnetite is in a lens about 1.3 meters long. No other magnetite is present in the limestone within 3 meters of this lens. The zone of magnetite and partly altered limestone is about 150 meters long, and the aggregate thickness of magnetite layers is estimated to average not more than 0.3 meter. No magnetite or altered limestone appears to cross the top of the ridge immediately north of and on the trend of the deposit, proving the discontinuity of the deposit. Tonnage was computed by considering the deposit to be 150 meters long, 0.3 meter thick, and to extend a distance beneath the surface equal to the surface length of the deposit, 150 meters.

Locality B

Several test pits were examined on the ridge extending east from Karaburun Tepe, but magnetite was seen only in and near one of the pits. Magnetite forms layers and pods in limestone on the north flank of the ridge, just north of the crest. Pods are as much as 0.3 meter thick and the magnetite zone is exposed for 20-30 meters. The magnetite zone trends south but does not cross the top of the ridge. The very well exposed slope immediately south of the crest of the ridge contains no magnetite. A trail crosses the trend of the deposit just north of the visible magnetite, but despite abundant rock rubble along it, no magnetite or other iron oxides were seen. The deposit therefore, clearly appears to be discontinuous.

Locality C

Magnetite is exposed naturally and in small cuts near the base of a slope at locality C. The magnetite replaces limestone, mainly parallel to bedding of the limestone to form a cluster of layers ranging from 1 mm to 10 cm in thickness. At the greatest concentration of magnetite in the deposit, the cluster of layers totals about 0.5 meter in thickness for a distance of 2 meters. Locally the thickness is approximately doubled by small-scale folding. The average combined thickness of the layers for the entire zone is estimated to be 0.3 meter, and the zone is about 12 meters long.

Locality D

Magnetite replacements of limestone are exposed in an open pit. Most of the limestone host rock is partly altered, probably dating from the emplacement of the magnetite by hydrothermal solutions, and has a yellow-brown color. The altered rock and some adjoining fresh limestone are laced with veins and pods of magnetite. The altered rock and most of the magnetite lenses trend east-southeast and dip about 45 NE. The altered zone is estimated to be 10 meters thick, but magnetite distributed through this zone and immediately adjoining unaltered limestone is estimated to total about 2 meters in thickness. Limestone just beyond the southeast end of the pit is devoid of magnetite, so the deposit definitely is discontinuous in that direction. Because of cover at the north-west end of the pit it is uncertain whether magnetite continues farther than the pit to the northwest.

Locality E

Magnetite is exposed in an open pit, and forms layers and veins in partly altered limestone. The deposit is southeast and on the trend of the deposit at locality D and the mode of occurrence of magnetite in the two deposits is similar. However, the lack of magnetite between the two localities shows that this deposit, like that at locality D, should be evaluated separately. Quite possibly the two deposits lie along the same stratigraphic or structural zone, but this would not assure continuity of magnetite in such a zone. The zone of altered limestone containing magnetite concentration is estimated to be 7 meters thick and 35 meters long, and the aggregate thickness of magnetite in the altered zone is estimated to average 1.4 meters.

Gilindire

Four areas containing concentrations of iron were examined in the southwest part of the Gilindire syncline (MTA Geologic report on Gilindire area; fig. 3). Two of the areas (marked A and B, fig. 3) are in a conglomeratic zone along the unconformity or disconformity between Jurassic and Cretaceous limestones. The other two concentrations (marked C, fig. 3) result from the action of solutions--probably surface and ground water--along one or more faults, are not part of the iron-bearing zone of interest in the syncline, and are not considered further. The MTA geologic map of the area shows that the ferruginous zone related to the Jurassic-Cretaceous contact extends discontinuously around the syncline. We have only evaluated those parts of the zone for which definite information about iron content is available. All such available information was obtained initially from exploration trenches by MTA and is given in the MTA geologic report on the area. The practice of using only definite information is justified by the lack of significant iron content revealed in trenches along parts of the zone, and by the great variations in thickness and amount of iron mineral concentrations, which make hazardous the projection of known data into unexplored parts of the zone.

The present examination supports the conclusion of MTA geologists that the iron-rich zone in the Gilindire syncline is located along and is interbedded with conglomerate and calcareous sandstone related to an

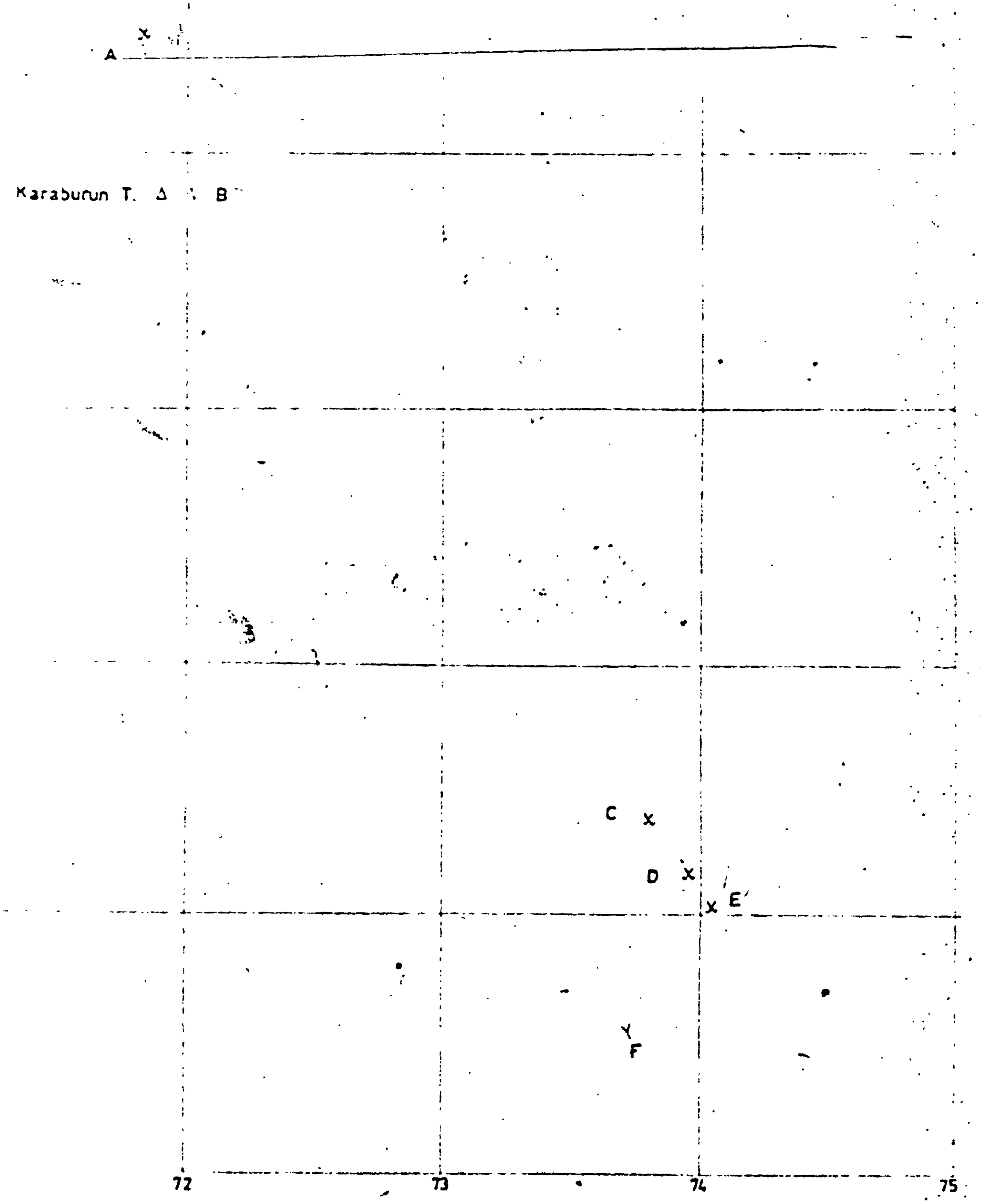


Figure 3 Sketch map showing locations of magnetite occurrences examined near Melleş. Scale given by kilometer grid lines taken from Alanya-P29-d3 1:25 000 topographic sheet

erosional break between two sequences of limestone. The iron was concentrated during and after erosion of the older sequence. The common presence of hematitic pisolites in the ferruginous zone, and the fact that much of the secondary iron is concentrated in the pisolites, indicates that iron was concentrated by diagenetic growth shortly after deposition and/or by later ground water percolating along the porous clastic zone. Irregular concentrations of iron can be expected to be inherent in this process.

Büyükeceli

(Zeytinkaya Tepesi)

One deposit of iron near the village of Büyükeceli, at the base of Zeytinkaya Tepesi, was examined. According to the MTA geologic report on this area, the deposit is the largest of four similar veinlike bodies in the vicinity of Büyükeceli. The deposit at the base of Zeytinkaya Tepesi is a messive body crossing the northeast trend of limestone beds at a large angle. The veinlike body trends about N60° W. It is about 160 meters long at the surface and its thickness at the surface ranges from 40-45 meters in the northwest half to about 5-10 meters in the southeast half. The iron is in the form of earthy and compact hematite and limonite that apparently formed by the weathering and oxidation of a vein of iron-bearing carbonate (siderite?). Large crystals of secondary carbonate (calcite?) are common in the oxidized ferruginous material. The change from oxidized rock to fresh limestone at contacts of the veinlike body is normally very abrupt. At the narrow southeast end, however, a small remnant of partly oxidized carbonate is left between the surrounding limestone and the fully oxidized material.

Payas

Two iron deposits in the Amanus Mountain Range near Payas overlooking the Gulf of Iskenderun--1 km northeast of Karayilanli village and at Kuzguncuk--were examined (fig. 4). The deposits have similar topographic geologic settings along the west-facing front of the Amanus Range. The iron is in one or more layers or lenses interbedded in Cretaceous or Cretaceous-Jurassic limestone. The deposits are 20-30 meters thick and consist of a very fine grained compact mixture of hematite and claylike material. The ferruginous layer at Kuzguncuk contains ferruginous pebbles and contributed ferruginous pebbles to the overlying limestone, so is clearly a sedimentary layer in which the hematite was present prior to deposition of the overlying limestone. The deposit northeast of Karayilanli contains pebble-like material and probably is similar in origin to that at Kuzguncuk. Iron content (evidently all in hematite), according to a Krupp Steel Co. report in MTA files, ranges from 20 to 40 percent, and alumina averages about 15 percent. The iron possibly was deposited originally as ferrous iron silicate mineral, and at unknown distances beneath the present or earlier erosion surfaces might exist in that form; however, the known iron at and near the present surface exists as ferric oxide. Drilling east of the Kuzguncuk deposit and exposures show the deposit in that area to be at least 500 meters wide (from east to west). Judging from the company report,

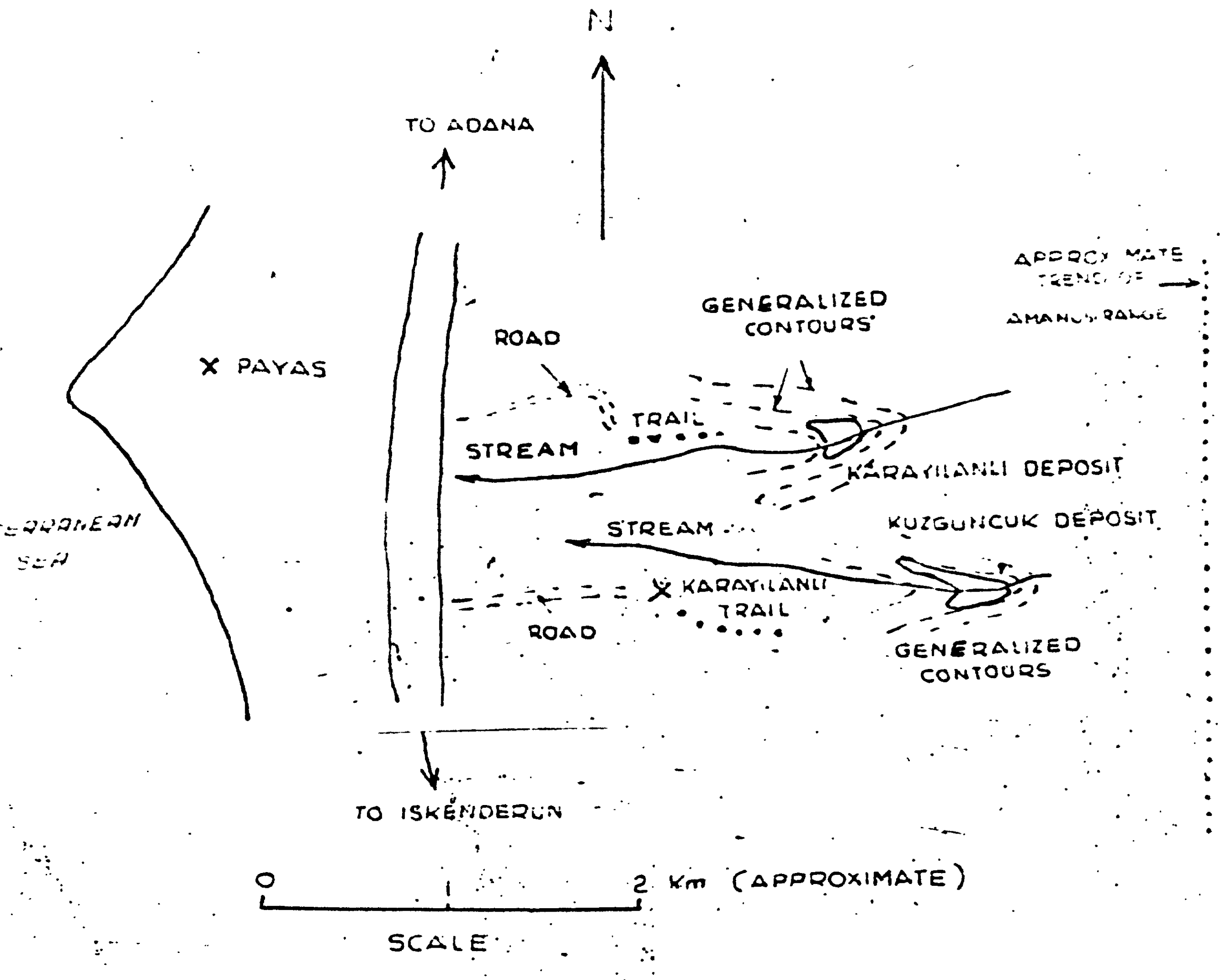


Figure 4: INDEX MAP OF TWO IRON DEPOSITS - NEAR PAYAS

the deposits examined are similar to a number of others located within a distance of a few kilometers. The limestones and intervening ferruginous layer or layers strike approximately northward parallel to the mountain front and dip gently eastward into the range. The maps and sections in the company report show that the iron deposits in the area are in several roughly north-south lines located at different altitudes parallel to the mountain front. The company report shows the limestone formations bounding the iron deposits to be the same regardless of the altitude at which they occur. This indicates, as shown in the company report, that block faulting parallel to the mountain front has elevated the range and with it the limestone formations and intervening iron deposits in successively higher steps eastward from the base of the range.

The iron beds examined and apparently most of the others described in the company report are known only where they cross the bottoms of stream valleys and extend along immediately adjacent valley walls, and from a few nearby drill holes and underground workings. The extent of the ferruginous rock downdip eastward and north-south under the ridges between the valleys is generally unknown. The iron deposits appear to be mainly at one stratigraphic position and their presence in adjacent valleys in places indicates that in each fault block they might extend continuously under the intervening ridges. However, continuity of the deposits cannot be taken for granted. They might originally have been deposited as lenses along one stratigraphic zone. Furthermore, large masses of serpentine that are present in the area apparently have truncated limestone beds in places and may also have disrupted a once-continuous ferruginous layer. Therefore considerable drilling will be necessary to determine the extent of known deposits. The estimates in the company report are probably as nearly valid as possible without additional drilling, but such estimates evidently are based to a considerable degree on unproved assumptions about the extent of deposits back into the mountainside from the outcrops. It is our understanding that the company estimates were based on assuming continuation of the ferruginous layer into the mountain for 100 meters back from the outcrop of each deposit, in computing a first category of reserves. A second category of reserves was calculated by assuming extension of the ferruginous layers for another 100 meters back from the outcrops.

Area southeast of Kirikhan

(Antakya P-36-b_2 and P-37-a_2 sheets)

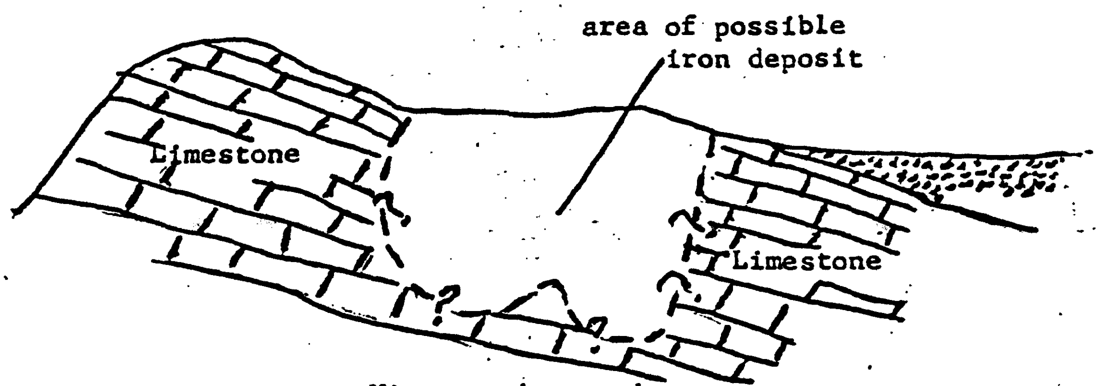
One previously known iron deposit was examined near the northwest end of an isolated limestone ridge in the Syrian graben east of the Amanus Mountain Range, about 15 km southeast of Kirikhan, and a possible deposit of similar material was found near the southeast end of the same ridge. The ridge is about 3 km long, trends northwest, and lies just southwest of and parallel to the road from Kirikhan to Reyhanli. Iron is present mainly as earthy to somewhat compacted hematite. Limonite is associated with the hematite. Ferruginous pebbles are seen in places in the deposit; some are surrounded by concretionary overgrowths of iron oxide. Rounded and frosted quartz sand grains are commonly mixed with the iron minerals and suggest deposition of both the iron minerals and the sand by sedimentation. Sand grains were not seen in the nearby limestone.

The limestone formation trends parallel to the ridge and dips 5° to 15° NE. The southwest flank of the ridge is a limestone cliff for nearly the entire length of the hill, whereas the northeast flank truncates gently dipping beds at a small angle near the known deposit and is conformable with steeper dipping limestone beds farther southeast. The known deposit is in sharp contact with surrounding fresh outcropping limestone and underlies a grassy area that extends from near the base of the ridge up the northeast flank to the top and slightly beyond. In plan the deposit is irregular, but is roughly as broad as it is long, and occupies a surface area of about 1/10 sq km. Small "islands" of limestone are present within the confines of the deposit.

The iron oxide is exposed in a number of test pits. Two pits near the base of the ridge are each about 2 meters deep and bottom in the ferruginous rock. Other pits farther up the ridge are all less than 1 meter deep and also bottom in the ferruginous material. One of the deeper pits on the lower part of the ridge is close to outcrops of limestone and cuts about 2 meters below the level of limestone. Therefore, although the present surface of the deposit goes upslope in seeming near conformity with the limestone beds, the base of the iron deposit must have considerable relief where it cuts into and across limestone beds. The indication of steep relief at the base of the iron deposit combined with the presence of limestone "islands" and the evidence of clastic sedimentation suggest that the deposit may be a filled sink-hole (John Albers, oral comm., 1969). If the deposit formed by the filling of a sink-hole it could be deep relative to its surface extent. An alternative origin of the deposit is that it is a shallow iron oxide-sand mixture along a stream channel that was bordered by low limestone cliffs. After deposition along such a stream the limestone and channel deposit could have been tilted to the present position. In such a case the iron deposit should be relatively shallow from the bottom of the slope to the top.

The possible iron deposit near the southeast end of the ridge is represented by a rather flat steplike grassy area cut into and across the dipping limestone beds (see sketch next page). The area covers about 1/20 km and is devoid of outcrops, but is covered by ferruginous soil that contains rather hard chips and fragments of iron oxide similar to that in the known deposit at the other end of the ridge. The ferruginous soil alone could not be considered particularly significant as an iron deposit because veneers of similar soil commonly develop over limestone in the area. The hard ferruginous chips do not occur elsewhere along the ridge, however, except at the known deposit. If the possible deposit is a filled sink hole, its topographic-geologic setting (see sketch below) would suggest that part of the filled sink hole has been beveled by erosion to produce the steplike area cutting across the limestone beds.

Limestone ridge



View to the northwest

Diagrammatic
sketch showing hypothetical form of potential iron deposit as filled sink hole in limestone.

Ulukisla

Two adjacent deposits of magnetite were examined a few kilometers east northeast of Ulukisla, on the north side of the Taurus Mountain Range near Nigde. The two deposits are essentially along one zone at contacts between a felsic igneous rock and limestone. The zone trends northeast and dips northwest into the mountainside north of the Ulukisla-Pozanti road. The two deposits are estimated to be 70-100 meters apart along the zone. At the northeastern most of the two deposits, magnetite is also present in blocky masses enclosed within the igneous rock. In places adjacent to the zone, limestone beds have been cut and more or less surrounded by the igneous rock; some limestone is partly replaced by magnetite along contacts with the igneous rock, and the blocky masses of magnetite enclosed within the igneous rock are interpreted as original limestone blocks that have been virtually completely replaced by magnetite. In detail, the concentrations of magnetite are irregularly distributed within each of the deposits. The two deposits end abruptly against igneous rock, and within the deposits separate small bodies of magnetite, magnetite-limestone, and limestone commonly end sharply against and evidently are truncated by the felsic igneous rock.

Other magnetite localities that were seen in the area appear to be very small and to be localized to contacts between bodies of igneous rock or in cracks, and are not considered here as sources of or guides to iron.

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