LAB 6: TRINIDAD BEACH FIELD TRIP

OBJECTIVES:

1) to develop your powers of observation, especially of geological phenomena;
2) to identify the rocks exposed at Trinidad Beach;
3) to reconstruct some of the geologic history of the Trinidad Beach area from the types and sequence of rocks exposed there.

INTRODUCTION:

An outstanding aspect of the geology at Trinidad Beach is the wide variety of rock types exposed in so small an area. The main rocks you will see are:

Greenstone - These rocks are slightly metamorphosed oceanic basalt, green because of their high chlorite content. Some of them contain rounded pillow structures, created when molten lava chilled against sea water. The greenstones represent old oceanic crust.

Greywacke sandstone - These poorly-sorted, dark-to-greenish-grey medium-grained sandstones contain volcanic rock fragments, quartz grains, pieces of shale, and other detrital material. They were deposited in oceanic trenches or at the base of the continental slope by turbidity currents.

Chert - These reddish, red-brown, or greenish cherts probably represent accumulations of diatom and radiolarian skeletons on the deep sea floor. The cherts are typically thin-bedded and highly folded. They are very hard and cannot be scratched with a knife blade

Serpentine - These shiny green rocks are metamorphosed peridotite, an igneous ultramafic rock that comprises most of earth's upper mantle. Serpentine is relatively soft and weathers to clay-rich "blue goo."

Schist and Gneiss - Depending on the tide and sand cover at the time of the field trip, you may be able to see one or more of representatives of these moderately to highly metamorphosed rocks, particularly near the northern end of the beach. Schist is rich in mica, and gneiss has prominent layers of light and dark minerals. Some of the schists contain greenish or bluish amphiboles and represent high-pressure, low-temperature metamorphism of greywackes and oceanic basalts in a subduction zone.

Gabbro and Diorite - Most of Trinidad Head is composed of mildly metamorphosed dark-colored gabbro and diorite. These rocks were originally part of the oceanic crust.

Unconsolidated and poorly-consolidated recent sediments - These relatively young and soft sands and gravels form the yellow cliffs at the south end of the beach. They represent sediments deposited in beach and near-shore shallow marine (e.g., breaker zone) environments.

The hard (i.e., well-consolidated) rocks listed above are part of an extensive rock unit, called the Franciscan Subduction Complex, which extends from southern California to Oregon. Franciscan rocks are exposed along much of the northern California coast and underlie much of the Coast Range. The Franciscan rocks are on the order of 60–120 million years old.

In this area, the pillow greenstones and bedded cherts have been tectonically jumbled together with greywacke sandstones, highly metamorphosed blueschists, once-vesicular basalts, and serpentinites to form a *melange*, a sort of tectonic "pudding" of hard resistant blocks embedded in a matrix of sheared shale, serpentinite, and greywacke. This sheared melange matrix weathers to a soft, sticky grey or blue-grey clay ("blue goo" or "grey goo"). The resistant blocks are exposed prominently on the beach as *sea stacks*; the sheared matrix is exposed in places at the base of the cliff. We believe melanges are generally formed in subduction zones as oceanic sediments and basement are scraped off the downgoing slab.

The greenstones represent lightly metamorphosed submarine basalts–the basic materials of the sea floor. The cherts are deep-sea sediments deposited on top of the greenstones. The greywackes represent turbidity current deposits in the trenches or at the base of the continental slope. The blueschists are sea floor rocks which have undergone low temperature but high pressure metamorphism as they were subducted. The serpentinite, which has been altered from peridotite, represents tectonically emplaced fragments of the earth's sub-crustal mantle.

Trinidad Head is a big block of plutonic igneous rocks, chiefly metamorphosed gabbro (metagabbro), embedded in the melange.

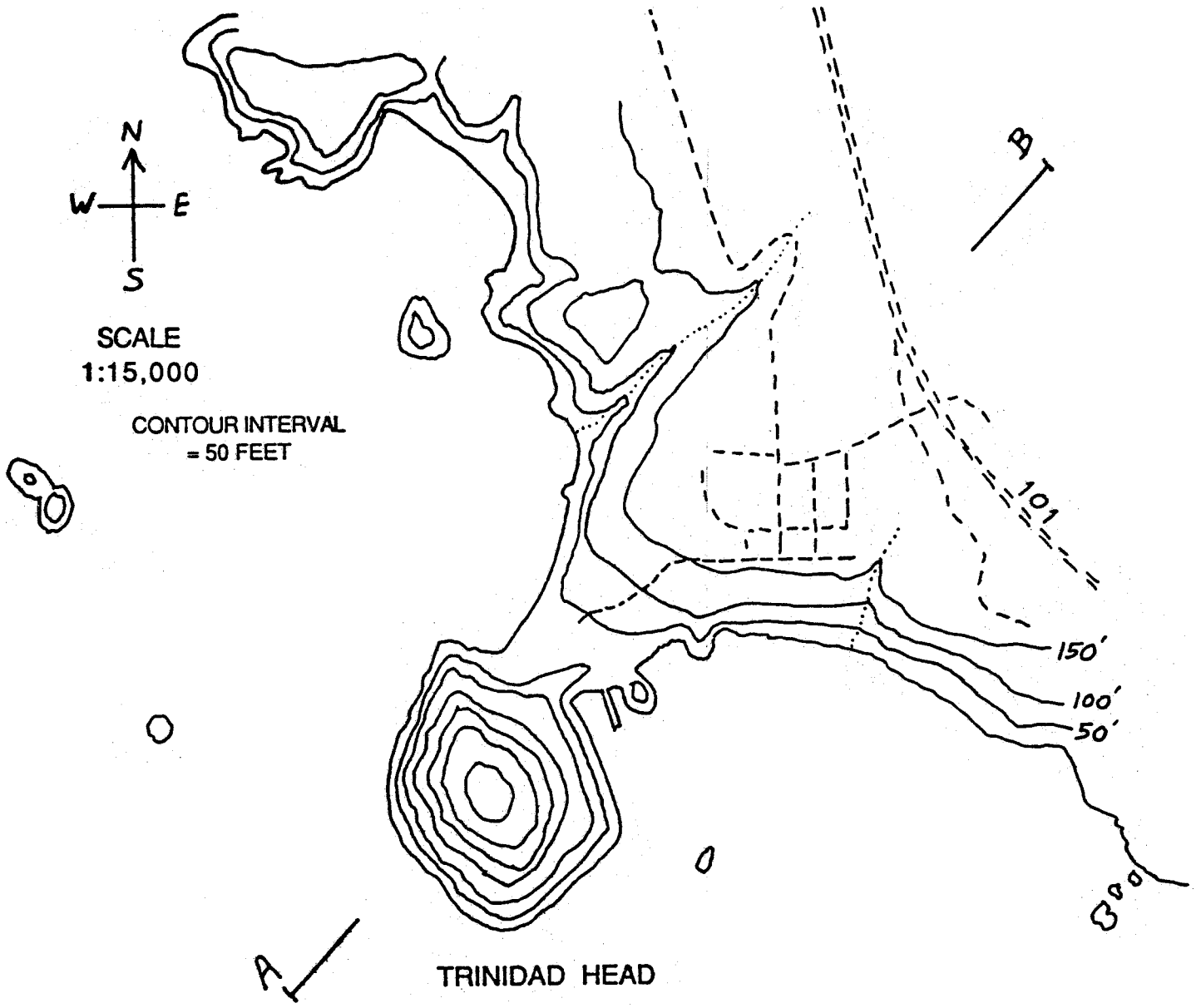
Overlying the Franciscan rocks in the cliffs at the south end of the beach are poorly consolidated sands and gravels of Pleistocene age. These sediments are probably no more than 400,000 years old, and may be considerably younger.

Our interpretation of the sequence of events is summarized below:

1. deposition of Franciscan rocks (basalt, greywackes, chert) on the deep sea floor 60 - 120 million years ago
2. compression, shearing, and metamorphism of the rocks as the oceanic plate was subducted beneath North America. The oceanic rocks are scraped off and welded to the edge of the continent.
3. great uplift and erosion to expose the hard Franciscan rocks
4. wave erosion of Franciscan rocks leaving some sea stacks on a wave-cut platform
5. submergence of the coast below sea level (about 400,000 years ago, we believe)
6. deposition of sands, which remain unconsolidated, on the wave-cut platform, filling in to the new (higher) sea level
7. coastal uplift, exposing the top surface of the unconsolidated sands as an uplifted marine terrace (approximately 83,000 years ago)
8. renewed wave erosion, chiefly of unconsolidated sediments. Present sea level is slightly below the level of the early wave cut platform. Buried sea stacks are exhumed.

TO DO:

1) On the following page, you will find a rough sketch map of the beach at Trinidad. The lettered rocks are sticking out of the sand or are partially covered by loose sediments in the cliff face. On the table next to the map, see if you can identify the rocks that are not already identified for you. If you have difficulties, ask your instructor. See if you can find examples of all of the rocks listed on the previous page, and possibly some that aren't listed!
2) Examine the cross-section below the topographic map of the Trinidad area, and attempt to reconstruct the post–Franciscan history of Trinidad in terms of relative changes in sea level which controlled the processes of erosion and deposition. At the beach, try to observe the evidence that allows us to develop the interpretation at the top of this page, especially steps 4 - 8.
3) Notice the way that the cliff face in the unconsolidated sediments is eroding.
    a. What causes can you see, or guess about, for the various forms of cliff collapse visible here?
    b. Would you build a house adjacent to the cliff?
    c. If so, how far back from the cliff edge do you consider to be safe for building? Why?
    d. Would a house on top of Trinidad Head be safer? Why?


N
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SCALE
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CONTOUR INTERVAL
= 50 FEET
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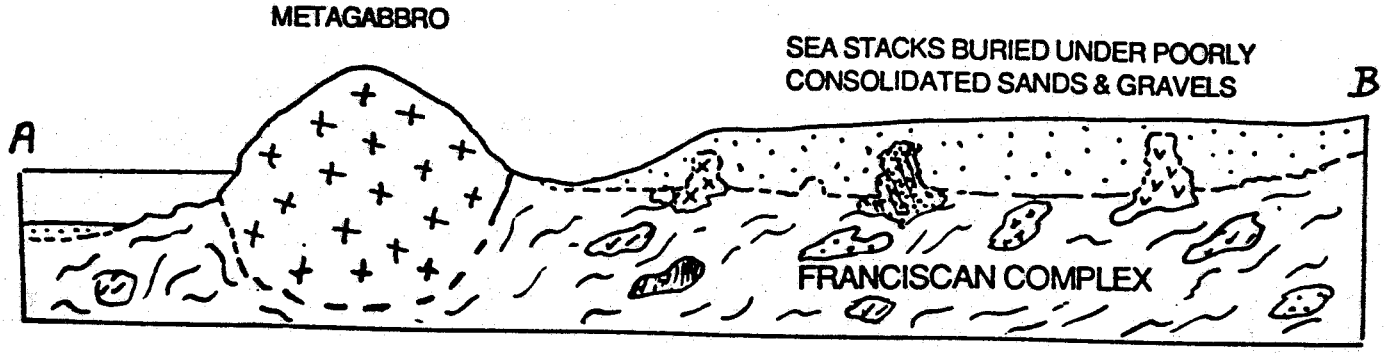
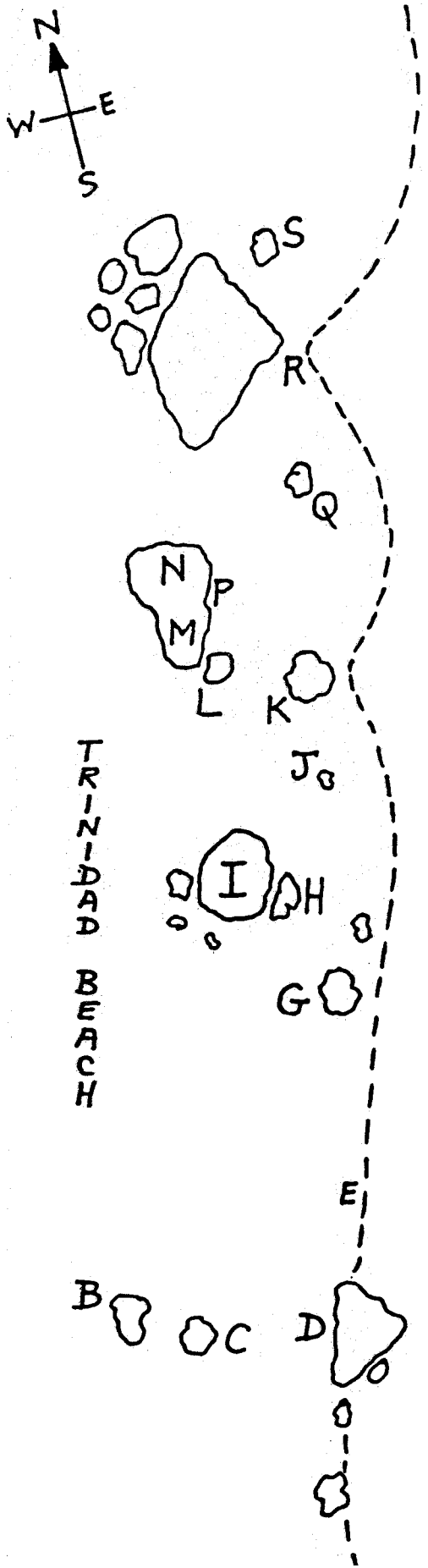
100'
50'
TRINIDAD HEAD


METAGABBRO
SEA STACKS BURIED UNDER POORLY
CONSOLIDATED SANDS & GRAVELS
A
B
FRANCISCAN COMPLEX

NAME: _____



S

R FAULT BRECCIA / SHEARED SERPENTINE

Q

P GREENSCHIST AND SHEARED ROCK

N

M GREENSTONE (METABASALT)

L

K

J FOLDED THICK-BEDDED CHERT

I SERPENTINITE + TALC? (SILICIFIED)

H BEDDED CHERT ON PILLOW GREENSTONE

G

F GREYWACKE SANDSTONE

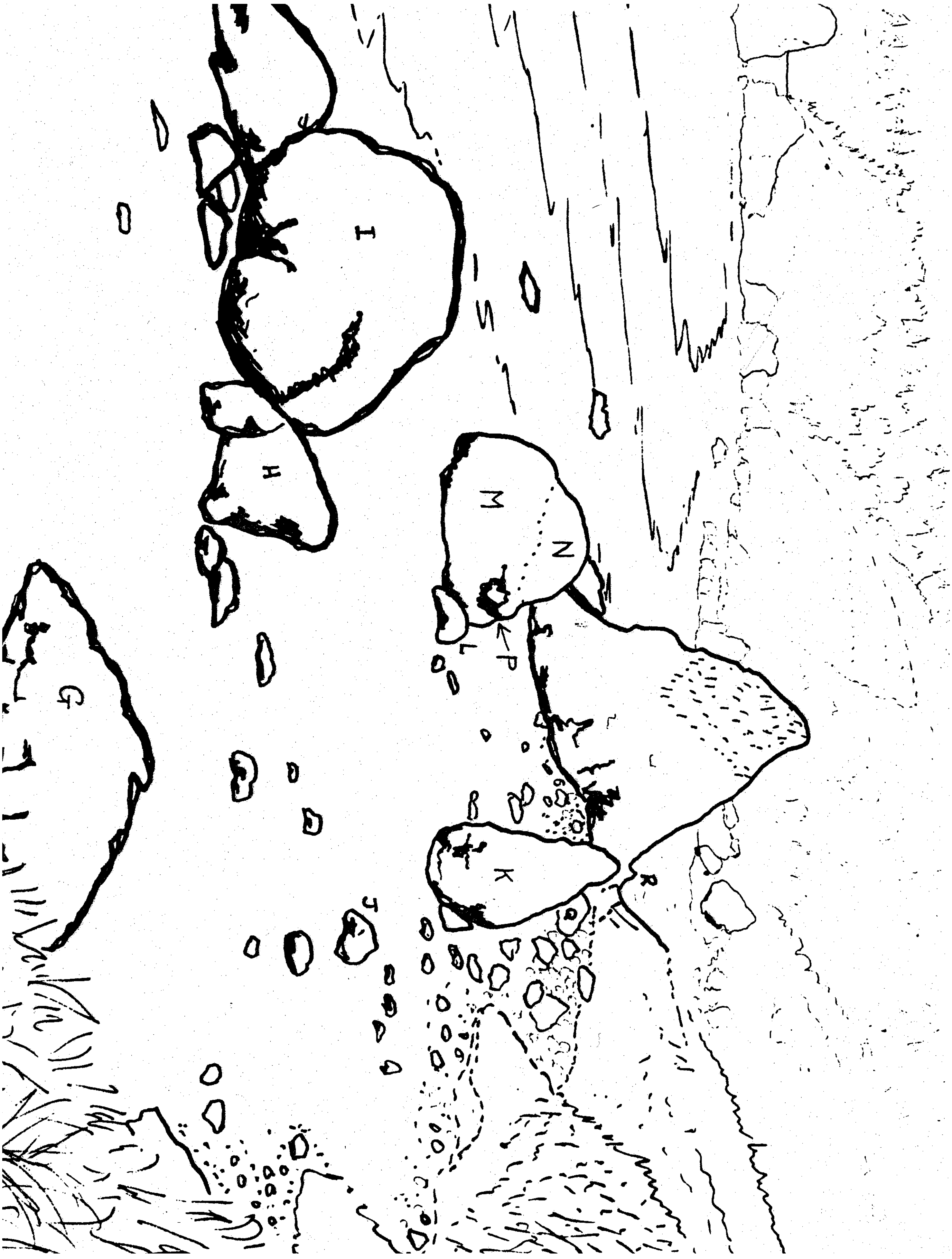
E

D

C

B PILLOW GREENSTONE

A



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L
P
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K
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