PROVENANCE OF SALTON DUNES, SOUTHWEST OF SALTON SEA, CALIFORNIA

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INTRODUCTION

The Salton Dunes are an interesting field of aeolian sand dunes located southwest of the Salton Sea within a five square mile area just east of California State Highway 86 about eight miles south of Salton City (Figure 1). The historic movements of the Salton Dunes have been studied from a comparison of maps and surveys for a period between 1941 and 1963 (Long and Sharp, 1964). The prevailing wind from the west, the adequate sand supply, the fairly smooth ground surface and the sparse vegetation allow formation of dunes (dominantly barchans) and their movement eastward at rates of 50 to 82 feet per year to their graves in the Salton Sea within a few hundred years (Long and Sharp, 1964).

PREVIOUS WORK ON THE SOURCE OF THE SAND

Several sources of sand for the Salton Dunes have been considered in the literature. Rempel (1936) commented that the beach line of ancient Lake Cahuilla (precursor to the Salton Sea) was located about eight or ten miles west and northwest of the barchans, and suggested beach sand as the chief source of sand for the dunes. Long and Sharp (1964) considered sources located to the west as much as twenty-five miles away, mainly from poorly consolidated Cenozoic strata but also from sandy beaches of Lake Cahuilla and fresh alluvium from large areas in Borrego and Clark Valleys. They felt the source was relatively local because the sorting is poorer and the percentage of well-rounded grains is less than in other California dune sands. Norris et al (1979) reviewed the dune field history, as well as an isolated barchan in Tule Wash (Norris, 1966), and were in agreement about the same western sources.

In order to assess the relative importance of the possible sources of sand, each suggested source area was visited and collected. Samples were taken from a barchan within the Salton Dunes, from weakly consolidated Cenozoic strata west of the Salton Dunes, and from modern sedimentation sites as playa, ephemeral creek, and local wind drift. The barchan samples are well sorted, fine sands and a moderately sorted, medium sand. Samples from the suspected sources have similar grain populations. Mineralogy was determined by point counts of two-hundred grains from each thin section using a mechanical stage. Mineralogical comparisons were then made between the suggested source samples and the dune samples.

MINERALOGY OF SANDS

The mineralogic composition of ten samples is shown in Table 1. The classification categories are mostly patterned after those used by Van de Kamp (1973) in his study of Salton Basin sedimentation. Basically, the sands are lithic arkoses comprised of 2/3 quartz, 1/6 feldspar and 1/10 rock fragments with lesser amounts of biotite, heavy minerals and lacustrine shell fragments.

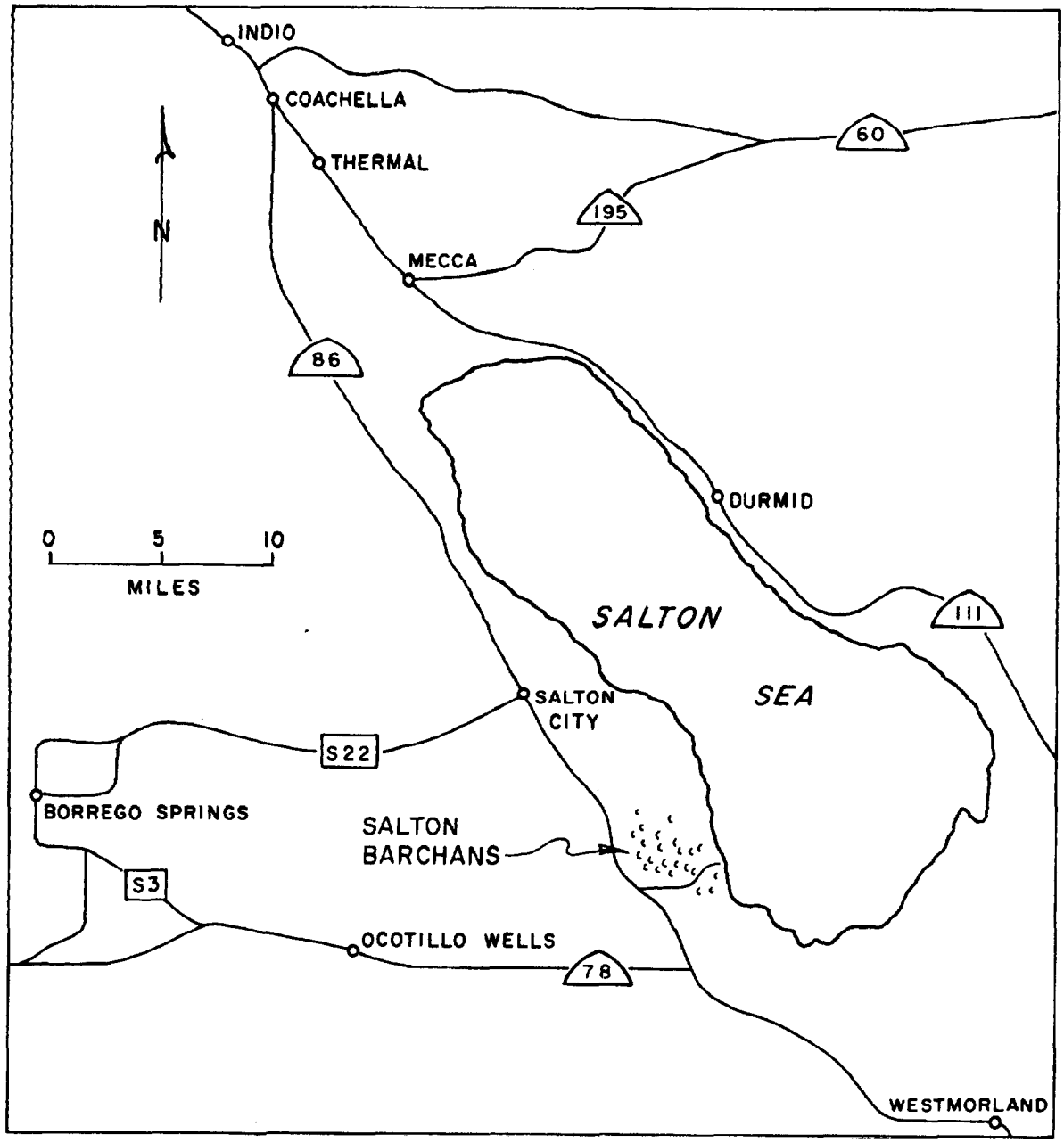

Figure 1. Location Map

The quartz grains are comprised of two-thirds plutonic quartz, one-quarter metamorphic quartz and about one-tenth vein quartz. Plutonic quartz grains typically have abundant vacuole trains with occasional biotite, rutile and zircon inclusions, and rarely microlites. Metamorphic quartz is generally the stretched polycrystalline variety showing sutured borders and undulose extinction. Grains of the recrystallized metamorphic variety occur in the larger size fractions. Vein quartz grains have very abundant vacuoles, which give a cloudy appearance to the grains. Quartz grain roundness varies from angular to well rounded.

Feldspars are comprised mostly of plagioclase and slightly less abundant orthoclase. Minor amounts of microcline are present, and rarely perthite. Although the climate is arid, the feldspars are usually fractured and generally show some alteration to clay minerals. Feldspar grains are mostly smaller and better rounded than quartz grains in the same sample.

The rock fragment component of the sand consists predominantly of metamorphic rock fragments (mrf) with lesser amounts of volcanic rock fragments (vrf), occasional plutonic rock fragments (prf) and rarer sedimentary rock fragments (srf). The majority of the mrf's appear to be from siliceous rocks with an appearance in thin section that resembles stretched metamorphic quartz with micro-crystals of elongate, lenticular shape and pronounced crenulated borders. These rock fragments might have been chert or volcanic ash that underwent metamorphism. Mrf's composed of elongated composites of biotite and quartz also occur. Vrf's appear as weathered grains displaying a texture of interlocking feldspar laths; some are slightly metamorphosed. Prf's are a composite of quartz and orthoclase or plagioclase and occasionally mica. Srf's are iron-stained siltstone fragments.

Heavy minerals consist mostly of amphiboles, primarily hornblende, and lesser pyroxene. They are usually very fractured and highly altered. Heavy minerals are most abundant in the smaller size fractions reflecting their originally smaller size.

Shell fragments composed of aragonite occur in all size fractions. Due to their softness, all the grains are well rounded.

PROVENANCE OF THE SALTON DUNES

The mineralogy of the samples collected from the Late Cenozoic strata (Ocotillo, Palm Spring, and Borrego Formations of Dibblee, 1954) compares very closely with the mineralogy of the Salton Dune sands (Table 1). In addition, extensive wind scour of these Cenozoic rocks is quite evident, particularly in the Palm Spring and Borrego Formations. Throughout the area, upwind from the dunes, are small accumulations of windblown sand in protected spots. The close comparative mineralogy strongly indicates that an important source of sand is the easily weathered Cenozoic sedimentary strata west of the Salton Dunes.

Lake Cahuilla beach sands are not common west of the Salton Dune field. Apparently sandy beaches were not extensively developed on the western side of the basin, or they have been considerably disrupted by Holocene erosion. The old shore line of Lake Cahuilla is quite obvious along Highway 86 near Travertine Rock where it appears as a prominent line of pale-buff travertine along the base of the Santa Rosa Mountains. Recessional strand lines are easily recognized, but these are considerably north of the Salton Dunes. Sykes (1914) observed that the northeast shore of Lake Cahuilla would have been subjected to the most intense wave action, whereas the southwestern shore would have received the least, being upwind and

TABLE 1. MINERALOGY OF SALTON DUNES
AND POSSIBLE SOURCE SANDS

	1	2	3	4	5	6	7	8	9	10
Quartz	68.0%	66.5%	68.5%	71.0%	70.5%	71.5%	71.5%	49.5%	50.5%	65.0%
Plagioclase	8.5	8.5	8.0	8.0	7.5	6.5	7.0	9.5	7.0	12.5
Orthoclase & Perthite	7.0	7.0	6.5	6.5	6.0	6.5	6.5	8.0	7.0	9.5
Microcline	1.5	1.5	1.0	1.0	1.0	1.5	1.0	2.5	0.5	0.5
Chert & Metamorphic Rock Fragments	6.0	5.0	5.5	6.5	6.5	7.0	6.5	8.0	7.5	3.5
Volcanic Rock Fragments	2.5	4.5	4.5	3.5	5.0	5.0	4.0	6.5	7.0	3.0
Plutonic Rock Fragments	1.5	1.0	0.5	0.5	0.5	0.5	0.5	-	0.5	-
Sedimentary Rock Fragments	0.5	-	-	-	-	-	-	-	0.5	0.5
Heavy Minerals	2.5	4.0	4.0	1.5	2.0	1.5	1.5	3.0	4.0	3.0
Biotite	0.5	-	-	1.0	0.5	-	1.0	12.5	14.5	2.5
Muscovite	-	-	-	0.5	0.5	-	0.5	0.5	1.0	-
Carbonate or Shells	1.5	2.0	1.5	-	-	-	-	-	-	-

SAMPLE LOCATIONS

1. A Salton barchan stoss slope
2. A Salton barchan crest
3. A Salton barchan slip face
4. Ocotillo Fm., Sec. 32, T.11S., R.9E., 12 miles west of dunes
5. Palm Spring Fm., Sec. 33, T.11S., R.9E., 10 miles west of dunes
6. Palm Spring Fm., Sec. 35, T.11S., R.9E., 8 miles west of dunes
7. Borrego Fm., Sec. 19, T.11S., R.10E., 6 miles west of dunes
8. Playa, Sec. 33, T.11S., R.8E., 16 miles west of dunes
9. San Felipe Creek, Sec. 35, T.11S., R.8E., 14 miles west of dunes
10. Tule Wash drift, Sec. 24, T.11S., R.9E., 7 miles west of dunes

sheltered under the lee of the mountains. Norris and Norris (1961) determined that the probable currents in Lake Cahuilla would have increased wave energy along the eastern shore. And, indeed, the shore line features along the northeastern and eastern sides are better developed than anywhere else around the rim of the basin. Along the western side the shore line is generally less prominent.

Van de Kamp (1973) collected samples from Lake Cahuilla beaches that are well developed on the southern and southeastern margins of the Salton Basin. The mineralogy of those samples is quartz-poor and vrf-rich thus showing little comparison with the Salton Dune samples. This lack of correspondence reflects the different source terranes on the western and eastern sides of the Salton Sea.

The only Holocene sample that compared favorably with the mineralogy of the Salton Dunes was taken from drift sand in the Tule Creek. Norris (1966) suggested that a share of sand in the Tule Wash dune was derived from local stream sands. He observed that about five percent of the sand grains from the Tule Wash barchan were composed of reddish, rounded, sand-sized aggregates of fine-grained silt. Because the silt aggregates are very soft and crumble readily when wet, they could not have been transported very far. This material forms as mud curls and dried puddle surfaces in low spots along Tule Wash and other drainages. The same reddish rounded aggregates occur in the Salton Dunes sand. The presence of these soft silt aggregates suggests that some of the Salton Dunes sand was derived from nearby stream washes.

In summary, the comparative mineralogy of the Salton Dunes sand indicates that Lake Cahuilla beaches and recent alluvium are not important direct sources of sand for the Salton Dunes. The only grains obviously contributed to the dunes from Lake Cahuilla sediments are the occasional detrital shell fragments. The principal source of sand for the Salton Dunes seems to be the poorly consolidated Late Cenozoic strata west of the dunes with a minor contribution from nearby stream washes.

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