Proposal for a Master's Thesis

Origin of the Coos Bay dune sheet, south central coast, Oregon

Submitted to

Department of Geology
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By

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Abstract

The Coos Bay dunes sheet lies between Florence and Coos Bay, Oregon and is managed by a branch of the USDA Forest Service known as the Oregon Dunes National Recreation Area. This area is experiencing many environmental pressures from sources with opposing uses. To manage this area effectivly, a higher level of understanding of geologic variables concerning sediment emplacement mechanisms and dates, in addition to sediment source, is sorely needed. With this data, a greater understanding and appreciation of the impact of the current rapid stabilization of active dunes via introducded vegitation will be gained. The work will be accomplished through a combination of dating techniques; quantitative soil color, thickness, and clay content analysis; sand grain size; sand thickness and depth trend analysis; and sand and clay mineralogic data. The work is expected to be done by winter 2000.

Approval

_____	_____
Curt Peterson, Thesis Advisor	Date
_____	_____
Ansel Johnson, Department Chair	Date

Introduction

I propose to determine the source, age and emplacement mechanism of the Coos Bay dune sheet encompassed by the Oregon Dunes National Recreation Area (see Figure 1), with the age determinations in collaboration with Errol Stock of Griffith University in Brisbane, Australia. The significance of this study is due to Oregon's coast being under increasing pressure from a variety of demands such as recreation, housing, wildlife, and aesthetics. With these increasing demands comes a need for increased understanding of how the landscape can cope with the provisions of each divergent use. About 45%, or 225 of the 500 kilometers, of the Oregon coast consists of active or partially stabilized dunes (Cooper, 1958). These landforms have specific land use concerns including slope stability, ground water resources, and wetland habitats. There has been no comprehensive studies performed to address these concerns. Whereas people have generally speculated off record about the timing and origin of the dunes, the origin and stratigraphy of the upland dune fields are not known. In this proposal, I expect to find the provenance of sand and the age and mechanisms of sediment emplacement.

Figure 1: Map of the Oregon Dunes National Recreation Area.

Area of study

The specific area of study I am focusing on is the Coos Bay dune sheet, nearly encompassed by the USDA Forest Service's Oregon Dunes National Recreation Area (see Figure 1), created by act of Congress in 1972. This area has many different, seemingly divergent purposes. The Oregon Dunes National Recreation Area (ODNRA) is home to extensive off-

highway vehicle (OHV) use, as well as other anthropocentric uses such as camping, hiking, fishing, and aesthetics. The area is also home to various species of terrestrial and aquatic organisms, most notably species with special statuses, such as the Snowy Plover, Bald Eagle, California Condor, and Southern Sea Otter (Pacific Coast Ecological Inventory, 1981). These habitats vie for attention with the human issues. To make competent managerial decisions, issues of current and past dune sand characteristics must be addressed.

The chief reason that this area was chosen for study was that it is the largest open dune sheet on the Oregon coast, nearly unbroken for its entire 70 kilometers and crossed only by two rivers, the Suislaw and the Umpqua. Therefore the interaction of modern active dunes and vegetated stabilized dunes could be studied from one geologic unit. In addition, this dune sheet is the largest non-Columbia River sheet in the Pacific Northwest, and subsequently is believed to be representative of the emplacement mechanisms of the other dune sheets in the region. With this information on dune emplacement, city and park managerial decisions would be more encompassing due to the additional knowledge of the sand's geomorphologic history. Therefore, this thesis will concentrate on the mechanisms of sand emplacement, with supporting data including; sand and clay mineralogy for provenance, grain size analysis for significant trends, sheet thickness and depth also for trends, and soil geochronosequencing coupled with absolute ages for a more complete overview of ages.

Background

Work focusing on the Coos Bay dune sheet has primarily concentrated on either broad studies of geomorphology (Cooper, 1958), or on a scale specific to particular factors, such as hydrology in the Florence (Hampton, 1963) or the Coos Bay North Bend area (Robinson, 1973).

The general overview by Cooper (1958) characterized many different factors of dunes in Oregon and Washington, and included the Coos Bay dune sheet. His model of emplacement mechanisms for Pacific Northwest coastal dunes was one of the shore front transgressing eastward during sea level rise with waves forcing the sand eastward in a number of cycles involving wind forcing, ridge building, wave erosion, and vegetation burial. Cooper is the primary generalized work for the Pacific Northwest. In addition to Washington and Oregon, he also classified California's coastal dunes (Cooper, 1967). According to Schultz, (1990) the existence and size of the dunes is due to two primary factors; a broad, flat terrace that slopes inland about 5.5 kilometers, and the size of the Umpqua and Suislaw rivers, whose sediment discharge supplies sand to the nearshore that the ocean can redistribute.

Other work has concentrated on littoral cell development on the regional scale (Peterson et al, 1991). Sand stabilization in the area has also been the subject of much study (Reckendorf, 1987; Carlson, 1991). Soil development in the dune areas has also been a major topic of study in the area (Bockhiem et al, 1996; Shoji et al, 1987; Baham and Simonson, 1985; Langley-Turnbaugh and Bockhiem, 1997). These papers do not all focus on soil development in sands, but they are all relevant to the processes on the Coos Bay dune sheet. For example, Bockhiem et al, (1996) studied the primary factors affecting the rate of pedogenesis and concluded that the chief factors influencing development were relative amounts of silt and clay; the ratio of quartz to feldspars in the very fine sand fraction; and the amounts of dithionite-extractable Fe and Al and crystalline Fe in the soil profile. All of these factors are seemingly applicable to the pedogenic processes in psamments of the dune sheet.

Ecological studies are also of importance to the understanding of the dunes. Worona and Whitlock (1995) classify the paleoclimatological variables at Little Lake, in the central Coast

Range, which translate to the south-central coast of this study. These researchers state that pollen data suggest a cooler and wetter climate than today from 42,000 to 24,770 ybp, evidenced by an open forest of western white pine, western hemlock and fir. The full interglacial period was colder and possibly drier than today. After this, the climate became drier and warmer until 5,600 ybp, marking the introduction of the present day cool, moist climate. Paleoclimate data is relevant to this study due to climate having a significant role in dune formation and morphology. Other studies not specific to this area will include grain size papers detailing the spatial distribution of sizes in coastal systems, grain entrainment papers, (Slingerland, 1977; Bagnold, 1936), and others as needed.

Statement of Problem

The question of sediment emplacement mechanism is one that has not been fully addressed or proven in previous work. There are two mechanisms for sand run-up are both are tied into sea level fluctuations: a high sea level stand, and a low stand model. The accepted, but unproven high stand model entails waves forcing beach sand onshore and subsequently into dunes during sea level transgression is the basis for the high-stand model. The mechanism for this model entails sediment going through repeated cycles of stabilization, re-activation by rising sea-level, and re-stabilization of sand at a higher level (see Figure 2). The result would likely be dunes of a uniform age with dates corresponding to the latest and highest advance of sea level. The low stand model, which shows potential of being the true model, entails sand being blown in from the exposed shelf and building up against Coast Range foothills primarily during the last glacial period, creating a lateral fining of sediments eastward and dates corresponding to glacial periods.

The significance of this research lies with the question of the sediment emplacement mechanism. It is possible that this question directly relates to the problems that are now being

Figure 2: Sea level rise and dune advance (Kellerman *in* Schultz, 1990).

experienced on the coast today. If the deposits are older, as with the low-stand mechanism, the over-vegetation now being experienced in the ODNRA signifies the loss of a moderate to long term geological feature. However, if the dunes are of the high-stand model, then we are losing a temporary feature.

The source of sediment is also in question. There are two major rivers within the bounders of the ODNRA, the Suislaw River to the north near Florence, and the Umpqua River in the mid-section near Reedsport. The mineralogies of each river are distinct, with the Suislaw draining the Coast Range volcanics and sedimentary units exclusively, and the Umpqua draining the Coast Range and the Klamath's metamorphic facies. Other sources considered for this study include the Columbia River, continental shelf sands, and rivers to the south in California. Distinctive heavy mineral assemblages should be useful in determining the sources and dispersal patterns of sand in the dune field.

Therefore, the primary questions that this research strives to answer are the ones of sediment source, age, and emplacement mechanism.

Objectives

The goals of this thesis is to determine the source of the sand contained in the Coos Bay dune sheet and the dates and mechanisms of sand emplacement in the area. This will be addressed through a combination of geochronological sequencing and absolute dating as outlined below.

- Sand mineralogy. The mineralogy of the sand will be analyzed and provenance determined. This will be done with the optical microscope and possibly with other interdepartmental equipment.

- Grain size analyses. The spatial distribution of grain sizes of sediment, both loose and in soil profiles will be examined for spatial trends relating to entrainment/settling velocity and pedogenic development.
- Sand thickness and depth. The thickness of the sand, along with the depth will be examined via state well logs. Trends exhibiting trends of thickness and depth, combined with other data, would provide information on sediment source directions. The data provided by the well logs will also include paleosol and aquifer variables.
- Absolute dating. Thermoluminecence, Optical, and ^{14}C dating techniques will be used to determine the sequence of sand emplacement and the timing of the emplacement and then correlating these dates to the rise and fall of sea level.
- Soil geochronology. A number of Australian Sand Auger cores and profiles from road cuts will be utilized for the relative pedogenic development of soil profiles. This will be tied into absolute dating and correlated, thus rating the reliability of such a model. Quantitative indexing will be based on soil colors using rubification (Harden, 1982), Buntly-Weston color indexing (Birkeland, 1984), B-horizon thickness, and clay content. Principle component analysis (Swan and Sandilands, 1995) of soil color constituents will also be performed.
- Clay mineralogy. Trends in the soil profiles will be examined by X-ray diffraction. Types of clay present, their possible source minerals and/or rocks, and relative concentrations will be examined. In addition to the stand-alone analysis, the respective spatial distribution of each will be examined and plotted.

- Paleo and recent climatic data. Paleoclimatic data matching absolute ages will be studied for its contribution to emplacement mechanisms. Modern climate trends will also be explored for its contribution to current sand movement.
- Other data to be explored in the literature include geophysical, pollen chronology, and archeological findings to provide further insight to sand emplacement, source, and other possible undetermined significant information.

Integrating all the above data should provide a viable answer to the questions of sand source and emplacement timing and mechanism.

Expected Products

The primary product that I will be producing will be an understanding of the mechanisms of emplacement and source of sand in the Coos Bay dune sheet. The tangible products of the study, as detailed below, will accompany this.

- An equation using soil variables, such as B-horizon thickness, color, and clay content, for the purpose of determining rough absolute ages for the duration of stability on vegetated dunes.
- Maps detailing the trends exhibited by grain size, thickness and depth of the sand, mineralogical patterns, as well as others, as their importance becomes known. In addition to these, I will produce maps showing any relevant trends in dune trends found as a result of the data analysis, with either a CAD program, or as GIS layers.

Budget

Expense	Amount	Total
Grain size and mineralogy	$2,500.00	$2,500.00
Grain texture and isopach map	$2,100.00	$4,600.00
Previous dating, including TL	$2.500.00	$7,100.00
Upcoming TL dating	$5,000.00	$12,100.00
Travel	$ 500.00	$12,600.00
Equipment	$ 100.00	$12,700.00
Total projected costs		$12,700.00

Much of the costs associated with this study will be provided by the ODNRA, with the remainder being provided at no cost by interested colleagues.

Schedule

- Prior to winter 1999: Field work and lab processing almost completed.
- Winter 1999: Propose and literature search for relevant papers.
- Spring 1999: Data processing.
- Summer 1999: Additional field work and data processing as needed, and begin writing thesis.
- Fall 1999: Finalize thesis.
- Winter 2000: Defend.

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