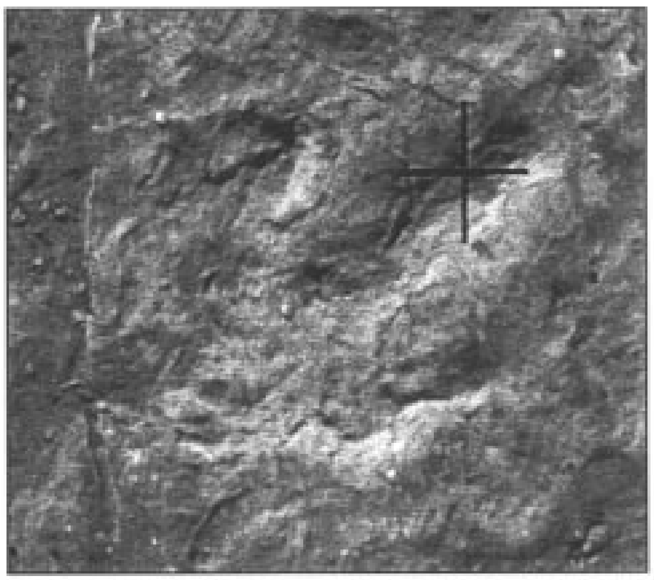
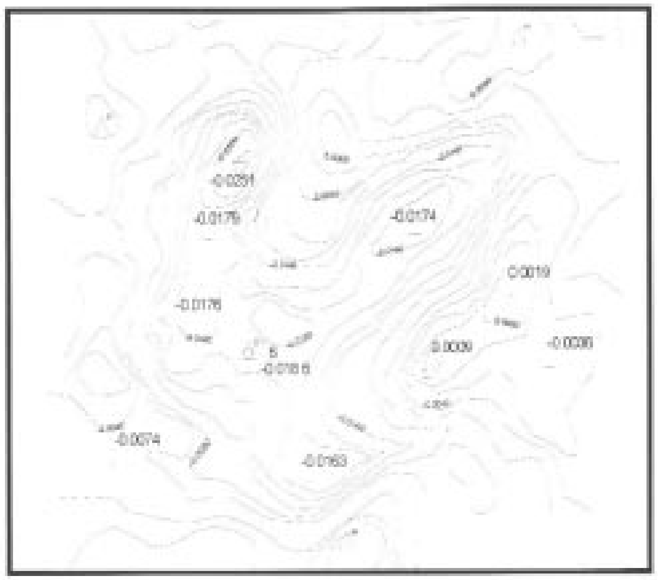
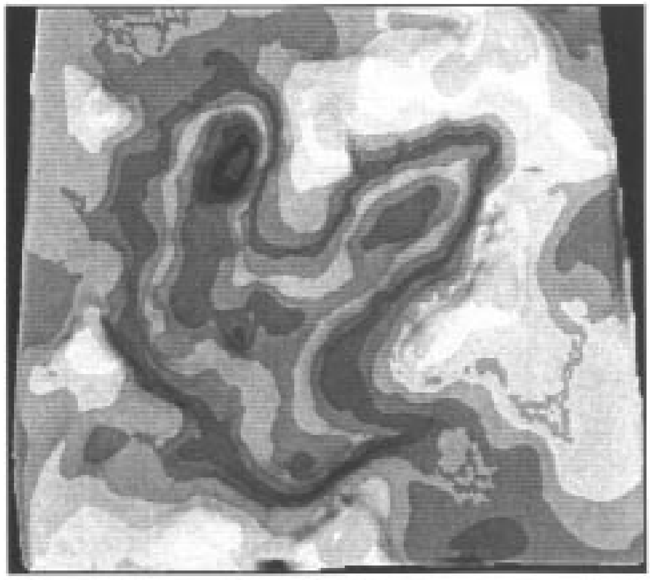
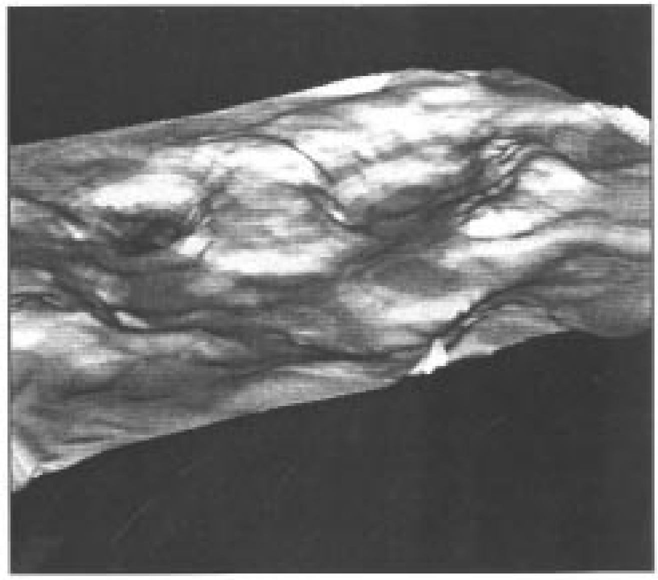
PROCEEDINGS OF THE 6TH FOSSIL RESOURCE CONFERENCE









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Cover Illustration
Photo of Red Gulch Dinosaur Tracksite footprint (upper left); digital contour of track (upper right); Digital Terrain Model of track, planar view (lower left); and Digital Terrain Model of track, oblique view (lower right).

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a fossil odyssey

PROCEEDINGS OF THE 6TH FOSSIL RESOURCE CONFERENCE

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ESTABLISHING BASELINE PALEONTOLOGICAL DATA FOR RESEARCH AND MANAGEMENT NEEDS: LESSONS LEARNED FROM THE NPS ALASKA REGION

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ABSTRACT—As part of a mandated inventory and monitoring program within the National Park Service, a large-scale study of paleontological resources has been initiated within the parks and monuments of the Alaska Region. This paper will discuss the complexities of working within the Alaska Region, and the preliminary data recorded. Within the Alaska Region, the scope of a paleontological survey is enormous, even for one park. A small team prospected accessible localities within six park units, targeted because the park management could provide either direct funding or in-kind support for the field inventories. The crew size was based on budget and logistics. The attention each park received was based on a combination of geology, weather conditions, personnel and other logistical parameters. Ground inspection revealed many inconsistencies or errors in the published geologic maps for each region. In one particular example, a region mapped as Early Jurassic in age has produced fossil evidence to suggest a Paleogene age for at least part of the region. This is particularly significant in this Park as there are no such rocks of Paleogene age previously identified throughout the western part of the park. Preliminary results from these surveys show great potential for future work. The scale of current mapping is insufficient to address both detailed paleontological questions and current resource management issues. More complete survey data will provide the needed baseline information for paleoecological questions within the Alaska Region, and throughout western North America for similarly aged rock sequences.

INTRODUCTION

As part of a mandated inventory and monitoring program within the National Park Service (NPS), a large-scale study of paleontological resources has been initiated within the parks of the Alaska Region. A preliminary survey of paleontological resources within NPS areas in Alaska was conducted in 1995 (Santucci, et al., 1995). The purpose of this report is to discuss the complexities of working within the Alaska Region, an enormous geographic area that contains many park units encompassing tens of millions of acres of land. In addition to the paleontological research challenges, these parks provide numerous logistical challenges that include extensive roadless areas, wildlife interactions, and extreme weather conditions. Of these many park units, we initiated paleontological investigations in six units, Aniakchak National Monument and Preserve (ANIA), Denali National Park and Preserve (DENA), Katmai National Park and Preserve (KATM), Kenai Fjords National Park and Preserve (KEFJ), Lake Clark National Park and Preserve (LACL), and Yukon-Charley Rivers National Preserve (YUCH). Partly as a function of funding, and partly as a function of scheduling, we have focused field activities in two park units, Aniakchak and Katmai. Therefore, we will discuss the preliminary data recorded from these parks that highlight the scale of paleontological issues, with respect to research and management needs, that face parks within this region.

These preliminary results show the potential wealth of paleontological information still to be gathered in each of these six parks. Further, as discussed elsewhere (Fiorillo et al., 1996) these discoveries illustrate the point that important management issues may include resources not traditionally recognized within individual parks.

WHY FOSSILS ARE IMPORTANT

It has been suggested elsewhere (Fiorillo, 2000) that perhaps no other subdiscipline of the earth sciences can make the singular claim of having the attention and enthusiasm of the general public, as can paleontology. Public fascination with fossils is historical, at least dating back to the earliest public displays of dinosaurs in the mid- and late 19th century. That this fascination with paleontology continues today is clear from the vast number of stories in the news regarding fossils. Similarly, college-level dinosaur courses are one of the two most popular earth science courses offered according to one survey, the other course being an offering on the geology of the national parks (Lessem 1994).

Federal land and resource managers concerned with the valuable paleontological resources under their care ask who should be allowed access to these resources? This question stems, in part, from increased public use of federal lands. It also is derived from the increasing tendency by some non-scientists to view fossils as commercial commodities, as evident in the recent announcements of scientifically significant fossils that have been sold at substantial prices (Reed and Wright, 2000).

Increased attention to fossils by federal land and resource managers is not only timely – it is imperative given the following: the broad range of public interest in fossils, the passionate advocacy of opposed special interest groups, the appeal that such controversy has among the media, and the economic and legal impacts of an expanded array of special uses of fossil resources across the federal estate. Given the economic and legislative issues at stake, a greater awareness of fossil resources on public lands is now mandatory.

METHODS

A team of resource managers and researchers was assembled to compile baseline paleontological resource data in the National Park Service units in the Alaska Region using the following criteria. First, resource managers needed to have a basic appreciation and understanding of paleontological issues. A team of such managers was identified and assembled. Second, NPS Alaska Region managers needed to establish partnerships with paleontologists familiar with the local fossils and the associated management issues. Though these initial surveys are research driven, development of products helpful to resource managers was also a significant component of the project. Paleontological researcher partners were identified based on previous paleontological projects within the National Park Service, or within similar federally managed, publicly owned lands.

Through successive meetings between primary parties, scientific objectives were outlined, funding strategies were developed and management needs were highlighted. After obtaining initial funding, responsibilities were divided along areas of training. Researchers pursued research objectives while managers assisted in logistical operations and developed criteria for products to assist park management staff.

In addition to the research benefits of this project, partnering with museum-based paleontologists provides the National Park Service with additional benefits that include access to additional experienced interpretive and exhibits staff, potential development of public education programs and exhibit programs that serve to increase public awareness of NPS park units. This increased public awareness by museum partnerships is particularly helpful to Alaska parks where visitation, compared to similar parks in the lower 48 states, is minimal.

The basic field design used in this study incorporated standard paleontological mapping and collecting methods. Extensive field notes and photographs were taken during the surveys and hand specimens were collected at key locations. Key sites were recorded using a hand-held GPS unit. Moving from one geographic area to another within a park required the use either of trucks, planes or boats, or a combination of these three. Use of these vehicles was often coordinated with other activities by park staff.

In some areas, such as within parts of Katmai National Park, survey activity was coordinated with the seasonal activities of the brown bear population to reduce the probability of bear-human conflicts. Also, given the remoteness of other areas, and thereby the high cost of accessing these areas, some aspects of work were intimately coordinated with ongoing biological surveys (i.e. salmon runs). Once an area was accessed, detailed surveys were performed on foot.

ANIAKCHAK NATIONAL MONUMENT AND PRESERVE

Aniakchak National Monument and Preserve consists of approximately 600,000 acres, and is one of the least visited parks within the National Park Service (Fig. 1). The park was established in 1978 to preserve the the immense volcanic features in the region. The most notable of these features is the 6-mile wide Aniakchak Caldera, a 2,000 foot deep circular feature produced by the collapse of its subsurface magma chamber after an eruption about 3,400 years ago (Miller, 1990). The recognized resources of the park include this volcanic feature and elements of the modern flora and fauna.

The area discussed here is along the Gulf of Alaska coastline in Aniakchak Bay, which currently has geologic map coverage (Detterman et al., 1981; Wilson et al. 1999). However, based on these previous published reports, differentiation between the geology of the two areas discussed below is ambiguous. Our paleontological observations clarify the

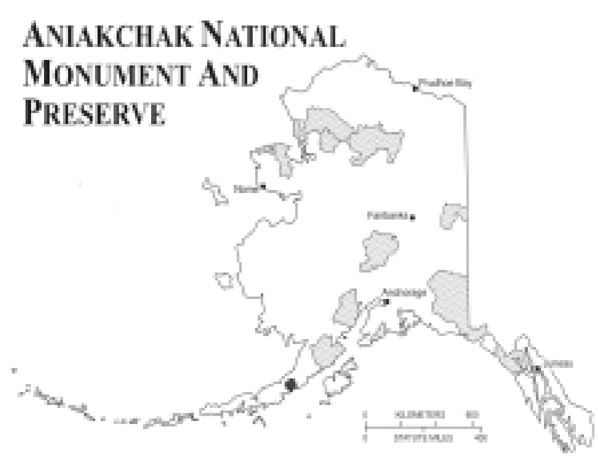

FIGURE 1. Map of Alaska showing the location of Aniakchak National Monument and Preserve.

geologic differences in the mapped Mesozoic geology along this part of the coast of Aniakchak National Monument and Preserve. Further detailed work in this park will likely clarify similar discrepancies.

The following comments are based on literature surveys and field observations. Field observations were made during a low elevation flight over the monument. The path of the flight was from King Salmon to the west side of Aniakchak Crater, past the Gates, and down the Aniakchak River to Aniakchak Bay (Fig. 2). At the bay, the flight proceeded north to the southern half of Amber Bay. A stretch of beach was chosen for a landing on the southern side of Cape Ayutka in what is mapped as Pleistocene material. Examination of outcrops occurred on the south side of Cape Ayutka proper on an unnamed point of land southwest of Cape Ayutka.

THE NAKNEK FORMATION

The investigation focused on the Mesozoic strata in Aniakchak National Monument and Preserve. More specifically, as vertebrate fossils have the highest proven financial value in commercial trade, the survey is focused on Late Jurassic through Cretaceous rocks approximately 150 – 65 million years ago. Included in this sequence is at least one rock unit, the Upper Jurassic Naknek Formation, that has great potential for producing skeletal material or footprints of dinosaurs.

In the Black Lake area of the western Alaska Peninsula a slab of rock has been photographed showing several tracks of a three-toed, predatory dinosaur, but its precise location is unknown (Gangloff, 1998). Given the approximate location of this slab, and unpublished geologic survey work on the Alaska Peninsula (Wilson, pers. comm., 2000), this slab is most likely in the Naknek Formation. The Naknek Formation extends through Aniakchak, Katmai and Lake Clark. Access to rock exposures is varied.

The Naknek Formation is the most widespread Mesozoic rock unit on the Alaska Peninsula, extending from the base of the peninsula southwestward to Black Hill. Spurr (1900) named the formation during the first comprehensive geological survey of the region. Though the exact application of the term has undergone some alteration in subsequent years (summarized in Detterman et al., 1996), most important to this report has been the subdivision of the Naknek Formation into members. From oldest to youngest, the Chisik Conglomerate, Northeast Creek Sandstone, Snug Harbor Siltstone, Indecision Creek Sandstone, and Katolinat Conglomerate Members (Detterman et al., 1981; Detterman et al., 1996). In general, these members represent a depositional change from a dominantly terrestrial fluvial system to a moderately deep to shallow marine environment. The maximum stratigraphic thickness of the Naknek Formation through the Alaska Peninsula is approximately 3200 meters, though the average thickness is between 1700 – 2000 meters (Detterman et al., 1996).

Based on marine invertebrate fossils, the age of the Naknek is generally considered as Oxfordian to Tithonian (Detterman et al., 1996). The approximate date for the basal boundary of the Oxfordian is 157 million years and that for the upper boundary of the Tithonian is 146 million years (e.g., Harland et al., 1989). These dates define the interval as the Late Jurassic.

THE CHIGNIK FORMATION

The Chignik Formation was named by Atwood (1911) for rocks exposed in the vicinity of Chignik Bay, southwest of Aniakchak National Monument. This Upper Cretaceous rock unit has a maximum stratigraphic thickness of approximately 600 meters in the type area of Chignik Bay, southwest of the boundary of Aniakchak National Monument and Preserve (Detterman et al., 1996). In the area of Chignik Bay, the Chignik Formation exhibits a cyclic pattern of nearshore marine, tidal flat, nonmarine channel and floodplain depositional environments. These are all potentially fossil vertebrate-bearing environments of deposition. However, the Chignik Formation rapidly changes character becoming exclusively marine to the northeast and southwest of Chignik Bay. The relationship of this change to the boundaries of Aniakchak National Monument and Preserve is unclear.

The age of this rock unit is late Campanian to early Maastrichtian (Late Cretaceous), based on marine invertebrate fossils. The Campanian-Maastrichtian boundary is

FIGURE 2. Cessna carrying paleontology field team lands on the beach along the coastline of Aniakchak Bay.

generally considered to be 74 million years ago (e.g. Harland et al., 1989).

CAPE AYUTKA

The rocks exposed at Cape Ayutka are identified as the Naknek Formation and are amply exposed as a continuous cliff. The rocks are fine-grained, dark gray siltstones. Buff colored concretions are common. Gastropods (snails) and pelecypods (clams) are common and diverse in type. In places along these cliffs pelecypods occur locally as dense shell beds. All snails occurred as isolated shells. Carbonized plants were rare. A typical large tree limb measures almost 20 cm wide and 100 cm long. One such limb of these proportions showed evidence of burrowing by an additional, unidentified fossil invertebrate.

UNNAMED POINT SOUTHWEST OF CAPE AYUTKA

These rocks are exposed as a nearly continuous set of cliffs. Contained in this set of cliffs is an igneous dike of unknown age. The sedimentary rocks in these cliffs are the Chignik Formation and consist of coarse sands with some conglomeratic layers. These conglomerates are up to 30 cm thick and contain pebbles up to 6 cm in diameter, though most are 4 cm or less. The pebbles are primarily crystalline material but a rare number of clasts appear to be made of coal. Plant debris is very common and includes fossil tree limbs up to 1m in length and pulverized plant debris forming mats along bedding surfaces. Towards the southwest end of these cliffs the sedimentary rocks become finer grained. No fossils were observed in this fine-grained sequence of rocks.

ANIAKCHAK CONCLUSIONS

Current geologic map coverage is ambigious along the coast of Aniakchak National Monument and Preserve. This ambiguity is due to: a) the fact that very similar colors are used on the geologic map in both areas discussed here (Detterman et al., 1981); b) the areal extent of each area on the map is limited and therefore presumably precluded clarification by standard map designations, and; c) the scale of the current map coverage is exceptionally large. This report shows that two distinctly different Mesozoic formations are present in the area and these rock units have very different fossil occurrences. Further detailed work will likely clarify similar discrepancies elsewhere in the Monument.

KATMAI NATIONAL PARK AND PRESERVE

Katmai National Park and Preserve is approximately 4,000,000 acres, and is one of the oldest National Park Service units in Alaska (Fig. 3). The national monument was established in 1918, and later expanded and granted park status in 1980. The proclamation of this unit as a national monument was based on the enormous 1912 eruption of Novarupta that produced ashfall for three days and covered 3,000 square miles with pyroclastic debris. Ash was deposited as thick as 200 meters in an area over 65 square kilometers that has since been named the Valley of Ten Thousand Smokes. The recognized resources of the park include this volcanic feature and elements of the modern flora and fauna.

Field checks of geologic maps at various points within the Park showed that, while useful in a very general sense, mapped specifics of park geology are in error. In the vicinity of Ukak Falls, significant discrepancies were evident between the mapped and actual contacts of rock units. This area is currently mapped as Quaternary with Jurassic rocks exposed nearby. However, numerous pelecypods (*Buchia*) and a belemnite were observed *in situ*, indicating Jurassic rocks at the Falls.

Of more profound significance however is the discovery of an unnamed rock unit along the shores of Naknek Lake in the vicinity of Dumpling Mountain (Figure 3), an area that currently has geologic map coverage. Given the magnitude of reinterpretation in this area, this discovery is discussed in some detail below.

DUMPLING MOUNTAIN - CURRENT GEOLOGIC MAP COVERAGE

Current geologic map coverage shows the prominent mountain next to Brooks Camp, named Dumpling Mountain, comprised entirely of the Early Jurassic Talkeetna Formation (Riehle et al., 1993). The Early Jurassic is generally considered to range from approximately 208 million years ago to

TABLE 1. Partial list of fossil plants from a new plant locality in Katmai National Park and Preserve.

Family	Genus	Modern Relative	Geologic Significance
Ulmaceae	*Ulmus*	Elm	
Juglandaceae	*Carya*	Hickory, Pecan	
Betulaceae	*Carpinus*	Birch	
Cercidiphyllaceae	cf. *Cercidiphyllum*	Katsura	
unknown	*Litseaphyllum*	Laurels, Cinnamon tree	Paleogene

FIGURE 3. Map of Alaska showing the location of Katmai National Park.

approximately 178 million years ago (Harland et al., 1989). Dinosaurs evolved approximately 225 million years ago and by the Early Jurassic they had started to become the dominant vertebrate life on earth. Flowering plants, or angiosperms, had not yet evolved. Given the accessibility of Dumpling Mountain from Brooks Camp, a paleontological survey of the mountain was initiated.

SUMMARY OF OBSERVATIONS

A protection ranger at Katmai National Park showed the survey crew a fossil plant locality that she had discovered a few weeks earlier. This site is located along the shore of Naknek Lake, northeast of Brooks Camp and consists of a medium to dark gray, massive siltstone. All of the plant material observed consisted of angiosperm leaves (Fig. 4). Table 1 is a partial list of floral remains recovered.

SIGNIFICANCE

This new fossil locality is unequivocally not in the Talkeetna Formation. This site is part of a rock unit that represents a previously unrecognized interval of geologic history for the entire western drainage of Katmai National Park and Preserve. As such, this site represents a previously unrecognized paleontological resource for the park.

FIGURE 4. Fossil leaf discovered near Dumpling Mountain, Katmai National Park.

The presence of these angiosperms clearly demonstrates a substantial revision in geologic age for part of the area around Dumpling Mountain. Angiosperms become the dominant flora by the middle of the Cretaceous, approximately 90 million years ago, but the age indicated by these floral remains is even younger. Based on the small sample of leaves observed at this site, this site is probably Paleogene in age, an interval of time that extends from 65 to 23 million years ago (Harland et al., 1989). Given the small sample size thus obtained however, a Neogene age cannot be definitively ruled out. Although negative evidence cannot be regarded as totally reliable, the absence of conifers supports the older age because conifers became common by the beginning of the Neogene.

WHAT IS THE ROCK UNIT CONTAINING THESE FOSSILS?

The floral remains suggest that this the site is Paleocene or lower Eocene in age, an interval of time from 66 to 50 million years ago (Harland et al., 1989). However, no such appropriate rock unit has been recognized in the region around Naknek Lake. There are several possible rock unit assignments for this fossil locality.

CHICKALOON FORMATION

The Chickaloon Formation is primarily recognized in the Matanuska Valley and the rock unit has been extended into the upper Cook Inlet region (Wolfe et al., 1966). The rock unit is a sequence of nonmarine sandstones, siltstones, coals, and conglomerates. The flora suggests a subtropical or at least a frost-free floral assemblage. Though it is rich in plant remains indicating a Paleocene age, the accepted extent for this rock unit is well northeast of the fossil locality in Katmai National Park and Preserve.

WEST FORELAND FORMATION

The West Foreland Formation has been mapped as far south as the Cape Douglas area of the Alaska Peninsula (Magoon et al., 1976). A more recent analysis of the rocks of the Alaska Peninsula has shown that the rocks in the Cape Douglas area are much different than those of the type area of the West Foreland Formation. Therefore, those rocks in the Cape Douglas area have been reassigned to the Copper Lake Formation (Detterman et al., 1996).

COPPER LAKE FORMATION

The Copper Lake Formation is a sequence of coarse to fine grained sedimentary rocks that are exposed along the Alaska Peninsula (Detterman et al., 1996). Current geologic mapping of Katmai National Park and Preserve shows these rocks on the Gulf of Alaska side of the park. This rock unit is the right age and is in the closest proximity to the new fossil locality. Given the current data for this fossil site, this locality may be an inland extension of the Copper Lake Formation.

KATMAI CONCLUSIONS

The recognized resources of Katmai National Park and Preserve include volcanic features and elements of the modern flora and fauna. A new fossil locality along the shores of Naknek Lake, near Dumpling Mountain, contains fossils that are inconsistent with the current mapped geology of the area. Based on the fossil recovered in the initial stage of a paleontological survey of Katmai National Park and Preserve, this locality is unequivocally not in the Talkeetna Formation.

This site is part of rock unit that represents a previously unrecognized interval of geologic history for the entire western drainage of Katmai National Park and Preserve. Given the current data for this fossil site, this locality may be an inland extension of the Copper Lake Formation.

Finally, this fossil site represents a previously unrecognized, important new resource for the park. Details of further work will provide Katmai National Park and Preserve with baseline data for management on this previously unrecognized resource. Further, these data can be incorporated in the General Management Plan for the Park, as well as help meet the servicewide goals of the National Park Service Strategic Plan for accountability of paleontological resources.

In addition to the scientific value of the site, given the proximity of this site to Brooks Camp, a major tourist destination for the Park, this site offers untapped interpretation opportunities for the Park, as well as presenting issues for law enforcement rangers.

DISCUSSION

The details presented here are decidedly preliminary and the paleontological points are not to be viewed as scientifically robust. Rather, we use these points to illustrate the fact that in an area as expansive as the Alaska Region, basic data are still in need of being gathered.

In the first example, Aniakchak National Monument and Preserve, the current geologic map coverage is ambiguous for the two mapped polygons in the coastal part of the Park. To a resource manager this ambiguity is significant given that one map polygon is comprised of rocks that have produced fossil vertebrates elsewhere while another map polygon does not. In a park with limited law enforcement resources, clarification of such ambiguities throughout the Park will allow park staff to focus attention where it is needed the most.

In Katmai National Park and Preserve, the current geologic map coverage is perhaps more problematic. Though in large-scale terms the maps are generally reliable, field inspection of mapped contacts between rock units shows inaccuracies. These inaccuracies are a small-scale problem for both researchers and land managers compared to discoveries of the nature of the new plant locality in the vicinity of Dumpling Mountain. In its current state, this new fossil locality is a new resource for Katmai National Park. After more detailed scientific investigation, this site will likely prove to be an important contribution to the understanding of the geologic history of the Park.

In summary, it is not our intention here to be critical of those who worked in the region before us. Rather, survey work in an area without a well-developed logistical infrastructure, like the Alaska Region, lends itself to questions regarding basic baseline data. Well coordinated teams of researchers and land managers can only serve to improve such databases, and these databases in turn can better serve the growing demands that are being placed on public lands.

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