The Application of Geologic Remote Sensing to Vertebrate Biostratigraphy: General Results from the Wind River Basin, Wyoming

RICHARD K. STUCKY

LEONARD KRISHTALKA

ABSTRACT

Since 1986, remote sensing images derived from satellite and aircraft-borne sensor data have been used to study the stratigraphy and sedimentology of the vertebrate-bearing Wind River and Wagon Bed formations in the Wind River Basin, Wyoming. Landsat 5 Thematic Mapper (TM) and aircraft Thermal Infrared Multispectral Scanner (TIMS) data have been combined with conventional geologic analyses. The remote sensing data have contributed significantly to: (1) geologic mapping at the formation, member and bed levels; (2) stratigraphic correlation; (3) reconstruction of ancient depositional environments; and (4) identification of structural complexity. This information is critical to vertebrate paleontology in providing the stratigraphic, sedimentologic and structural framework required for evolutionary and paleoecologic studies. Of primary importance is the ability to map at minimal cost the geology of large areas (20,000 km² or greater) at a high level of precision. Remote sensing data can be especially useful in geologically and verteontologically unexplored or poorly understood regions.

INTRODUCTION

Remote sensing data from satellite and aircraft-borne instruments can provide significant geologic information on vertebrate-bearing sedimentary rocks. Such data have been used since 1986 in, and are now integral to, a long-term project that focuses on the vertebrate paleontology and geology of the Eocene Wind River and Wagon Bed formations in the northeastern Wind River Basin, Natrona and Fremont counties, Wyoming (Stucky and Krishtalka, 1982; Stucky, 1988; Stucky et al, 1987, 1989, 1990; Krishtalka et al, 1988). The remote sensing data have provided new information as well as augmented conventional analyses of stratigraphic interpretation, reconstructions of sedimentary environments, and determinations of structural relationships of these geologic units, thus allowing an enhanced understanding of the geological context that is necessary for evolutionary and paleoecologic studies of fossil vertebrates. This work has been conducted in conjunction with the NASA Sedimentary Basins Project in collaboration with the Jet Propulsion Laboratory.


METHODS

Remote sensing data derived from the Landsat Thematic Mapper (TM) and Thermal Infrared Multispectral Scanner (TIMS) have been used. These instruments detect either solar reflected or re-emitted energy in the visible and near infrared (TM) and thermal infrared (TIMS) parts of the electromagnetic spectrum (Goetz et al, 1985). Basically, because of differences in elemental composition and molecular structure, different earth materials reflect and emit differentially energy in the electromagnetic spectrum.

The Landsat TM data analyzed here are based on the visible and near infrared spectrum in six bands of information from 0.45 to 2.35 micrometers; the TM band at 10.4 to 12.5 micrometers is not used in the analyses here. Principal component (PC) analysis was performed on data from the six bands derived from a composite training area of terrains with well exposed Paleogene rocks. The eigenvectors of either PC-I, PC-II, and PC-III or PC-II, PC-III, and PC-IV were used to predict values for each