While many of the sediment of the Great Valley and waters that probably included large populations of microscopic, low density sedimentary particles; there being fossilized. 2) Deepwater sediments have a much lower representation of fossil dinoflagellates than sediments deposited under shallower conditions. 3) Dinoflagellate remains capable of fossilization were microscopic, low-density sedimentary particles; therefore, they tended to be winnowed out of the coarser clastics, accumulating, rather, in clayey siltstones or still finer sediments. While regionally indigenous fossil species are common, the planktonic nature of most dinoflagellates assured that many species have a geographically broad distribution.

Although megafossils and foraminifers have been the basis for a few critical dates in Franciscan—a designation which will be used here to include associated sediments for which the appropriateness of the term "Franciscan" has been disputed—strata, these fossils occur too infrequently and are too poorly preserved for them to be broadly applicable to Franciscan problems. Other microfossil groups, although not without severe limitations, appear to hold real promise. One of these is the Radiolaria, with a bright future in Franciscan stratigraphy resting on new extraction techniques (Pessagno and Newport, 1972) which are now being applied with marked success in California (Pessagno, 1975; 1977). Another group, the dinoflagellates, is the topic of this note, whose purpose is to review some aspects of the application of these fossils to the dating of Franciscan strata.

DATING WITH DINOFLAGELLATES

The potential of dinoflagellates for dating the Franciscan is related to several factors, including their original abundance and distribution in the sediments, their status as recognized time indicators, and the feasibility of their recovery and identification from Franciscan strata.

Original Abundance and Distribution

Dinoflagellates are microscopic (20-150um) algae commonly encountered in Jurassic, Cretaceous, and Early Tertiary marine sediments. Very few examples of fossil freshwater dinoflagellates are known, although they are common in freshwater situations today. Consequently the presence of a variety of fossil species is presumptive evidence of marine deposition. While many of the sediments of the Great Valley and Franciscan sequences, as well as other sediments of the California Coast Ranges, were deposited from waters that probably included large populations of dinoflagellates, their potential usefulness to the stratigrapher is limited by three considerations relating to their original occurrence and distribution: 1) Only a fraction of the individuals in an assemblage of living dinoflagellates produces remains capable of being fossilized. 2) Deepwater sediments have a much lower representation of fossil dinoflagellates than sediments deposited under shallower conditions. 3) Dinoflagellate remains capable of fossilization were microscopic, low-density sedimentary particles; therefore, they tended to be winnowed out of the coarser clastics, accumulating, rather, in clayey siltstones or still finer sediments. While regionally indigenous fossil species are common, the planktonic nature of most dinoflagellates assured that many species have a geographically broad distribution.

Status as Time Indicators

The study of fossil dinoflagellates goes back to Ehrenberg, the so-called father of micropaleontology, in the early 1800's. However, only in the last 20 years have they received the concentrated attention that makes them today one of the "hottest" items in the micropaleontologist's repertoire. The impetus for this attention has come, as it did in the case of the Foraminifera several decades earlier, from their demonstrated value for dating and correlation in the field of petroleum exploration. The broad pattern of fossil dinoflagellate distribution through time is now quite clear, and the techniques for regional and inter-regional dating and correlation are well established. It remains to be seen what ultimate precision can be reached with them, but probably it will be—and, for some areas and parts of the stratigraphic column, already is—at a level comparable to that for the Foraminifera. At the present time a reasonably varied fossil assemblage from a sample of unknown age should certainly be determinable to near a geologic stage, and intraregional correlations can be carried out with considerably greater precision than that. Of course, in an ideal situation, one unequivocal example of a single species may be all that is needed to provide a critical date.

Feasibility of Recovery and Identification from Outcropping Franciscan Strata

Here reality sober's wishful thinking, making the solution of stratigraphic problems in California by dinoflagellates from outcrop samples a less than "sure-fire" procedure. Preservation is the chief problem—preservation as influenced by postdepositional geologic history and by recent weathering. Both factors are critical mainly because of the composition of the fossil dinoflagellates most likely to be encountered. These are of organic composition, in contrast to the mineralized remains of, say, foraminifers and radiolarians. The organic components of the fossil dinoflagellate are highly resistant to many processes, which enables them to be recovered by techniques that involve digesting rock samples in a succession of acid and caustic baths, but they are sensitive to both high temperatures and to oxidation, the former associated especially with deep burial, the latter favored by California's climatic regimes.

In samples that have had a long history of deep burial, the organic materials of the dinoflagellate wall are modified in the same manner as coal or other vegetable matter, with a similar increase in "carbonization" and a corresponding loss in the morphological detail necessary for precise identification of