3.1 Aside

In the early 1970s, a series of “second-generation” plate tectonics papers appeared in which the reconstruction techniques introduced by Bullard, Everett and Smith (1965) were progressively modified and applied to magnetic isochrons and paleo-fracture zones. McKenzie and Sclater (1971) attempted the first model of opening of the central Indian Ocean. Their technique involved fitting fracture zones with an instantaneous pole and assuming constant spreading rate to fit segments of the Maldive Ridge (African plate) to the Chagos Ridge (Indian plate).

Pitman and Talwani (1972) and Weissel and Hayes (1972) introduced a different technique in their analyses of the North Atlantic and southeast Indian Ocean, respectively. They applied trial-and-error total rotation fits of magnetic anomalies and fracture zone offsets to the North Atlantic and southeast Indian Ocean. Their contributions were particularly exciting insofar as they showed that differential reconstruction parameters derived from the total reconstruction parameters could be used to approximate plate kinematics; further, flowlines derived from the resulting stage poles could be compared with observed fracture zone trends as an additional test of the reconstructions.

A further advance came with Atwater and Molnar (1973) and Molnar and Atwater (1973), who combined sequential reconstructions from adjacent oceans to derive global reconstructions. The nature of the results these and other workers put forward motivated me to attempt global reconstructions that incorporated the Nazca plate and its motion relative to South America and North America (for the time prior to 25 Ma, when the Nazca plate was part of the larger Farallon plate). I went further and developed a plate reconstruction technique based on McKenzie et al.’s (1970) continental reconstruction method and applied it to Pacific–Nazca reconstructions. After reproducing and modifying, to an extent, the Pacific–North American analysis of Atwater and Molnar and applying it to US Cordillera and coastal California, I applied the techniques to an analysis of the plate tectonic history of the South American Andes in a series of three papers in the early 1980s. These analyses were particularly exciting in that dated Cenozoic volcano-tectonic histories of the two Cordilleras could be shown to correspond with predicted plate motions.

The idea of correlating distinct geological phenomena with plate motions still has a profound appeal. Dewey and others (1973) attempted to interpret the evolu-
tion of the Mediterranean and Alpine region in the context of Pitman and Tal­
wani's oceanic reconstructions, with some success. Atwater and Molnar (1973) pro­
vided some intriguing constraints on the evolution of the San Andreas fault system,
providing additional support for the speculations Atwater (1970) had previously
advanced regarding the Late Cenozoic evolution of western North America.

What was particularly exciting for me was the correspondence of global recon­
structed motions of the Pacific, Farallon, and North and South American plates
with magmatic histories recorded in isotopic age dates. However, there has always
been the objective uncertainty in the reconstructions – has Antarctica behaved as
a single plate or is there a hidden plate boundary under the ice? Until the Antarc­
tic plate problem is resolved, the apparent correlations of circum-Pacific plate
motions remain apparent.

3.2
Basics

Spherical coordinates provide the most easily visualized parameterization of the
displacement of points on the surface of the approximately spherical earth. A va­
riety of map projections provide a two-dimensional view of earth data, while fa­
miliarity with model globes facilitates graphical comprehension.

Latitude (\(\phi\), or colatitude \(\phi_c\)) and longitude (\(\theta\)) of a point on a unit sphere are
related to Cartesian (\(x, y, z\)) coordinates as:

\[
x = \sin\phi_c \cos\theta = \cos\phi \cos\theta \tag{3.1}
\]

\[
y = \sin\phi_c \sin\theta = \cos\phi \sin\theta \tag{3.2}
\]

\[
z = \cos\phi_c = \sin\theta \tag{3.2}
\]