Introduction

So what is the Colorado Plateau, anyway? We have all been told that the magnificent splendors of Grand Canyon, Zion Canyon, Bryce Canyon, Capitol Reef, Canyonlands, Arches, and Mesa Verde National Parks lie within the Colorado Plateau, but where does the Colorado Plateau begin and end?

To the geographer, the Colorado Plateau Province is a broad expanse of generally flat country, dotted here and there by high mesas, pinnacles, and smaller plateaus and incised in places by deep canyons. The region is punctuated with random and isolated rounded mountain ranges, known as laccolithic ranges, formed by molten rock that squeezed into the stratified rocks. The province is generally high, averaging something like 5,000 feet in elevation with low average precipitation. Thus, it is a high, semiarid desert. The Colorado Plateau constitutes a large part of the drainage basin for the Colorado River and its many tributaries. It is not located in Colorado alone but lies in Utah, Arizona, and New Mexico as well. The surrounding provinces constitute various complex mountain chains.

To many it is a bleak and threatening region: summers are very hot, winters are very cold, and water is almost nowhere. For those folks it is a place to be avoided or, at best, to get through as quickly as possible. For them the interstate highways are a blessing. Still others are fascinated by the stark beauty of it all, especially those brave folks who wander off the beaten paths. The highways that interlace the larger towns and cities were built on the flattest and most drab-colored strata, avoiding topographic relief such as mesas and canyons for economic reasons. When one ventures onto roads that go "nowhere," the excitement begins. Red rock badlands are everywhere. Pinnacles and buttes of spectacular proportions dominate the landscape. And canyons, large and small, are ubiquitous. Beauty reigns. Unbelievable shapes and colors abound. As an ancient Navajo poem concludes: "Beauty all around us. With it I wander."

There are as many different boundaries of the Colorado Plateau Province as there are experts in the fields of geomorphology (the study of the origin of landforms), geology (the study of rocks), and geography (the study of the surface of the earth). Generally speaking, the Colorado Plateau is a vast expanse of relatively flat-lying strata sandwiched between regions of complexly organized mountainous terrains. But the boundaries of these flat-lying rocks are fuzzy at best. It is easy to say that mountainous regions surround the Colorado Plateau, and thus define it, but where does a mountainous region end and a generally flat plateau begin? The answer is that the transitions are gradual and the boundaries are broad zones that lack distinctive lines of demarcation; thus, the boundaries are subject to varying interpretations by different authorities. But the real question is, Why? What has caused the Colorado Plateau to stand alone in the midst of all this mountain-building activity? The answer lies in an understanding of the geologic features and processes that have formed the earth as we see it today.

The region known as the Colorado Plateau is a geologic entity unto itself, a relatively stable block of the earth's crust set apart by major, ancient fracture zones. Some would blame this anomalous block on some quirk of plate tectonics, the idea that continental "plates" migrate around on the crust of the earth, first gurgling up at the oceanic ridges only to slip away into the depths of the earth or crash into one another. Although plate tectonics is a popular concept, it does not necessarily apply to the geology of continental interiors.

An alternative to the understanding of continental geological processes proposes that major fracture zones in the very ancient Precambrian basement (rocks that originated more than 550 million years ago) control the location and orientation of the various major geologic features. These ancient fault zones have apparently controlled geologic features since about 1.7 to 1.6 *billion* years ago and have been reactivated repeatedly throughout geologic time. It should be noted here that a *fault* is a fracture in the earth's crust along which movement has taken place. There are several varieties of faults, but in this case we are dealing with faults along which movement has been mainly lateral (strike-slip), much like what is happening in the San Andreas fault zone in southern California today. These faults usually occur in complex swarms and are known as *wrench faults*.

The pattern of the major basement wrench fault zones on the Colorado Plateau is one of northwest-southeast–directed faulting and northeast-southwest–oriented fault zones, the two trends intersecting at regular intervals and usually offsetting each other at the intersections, forming "trellis" patterns. In addition, there are the occasional north-south or east-west faults that punctuate the overall pattern (Figure 2).

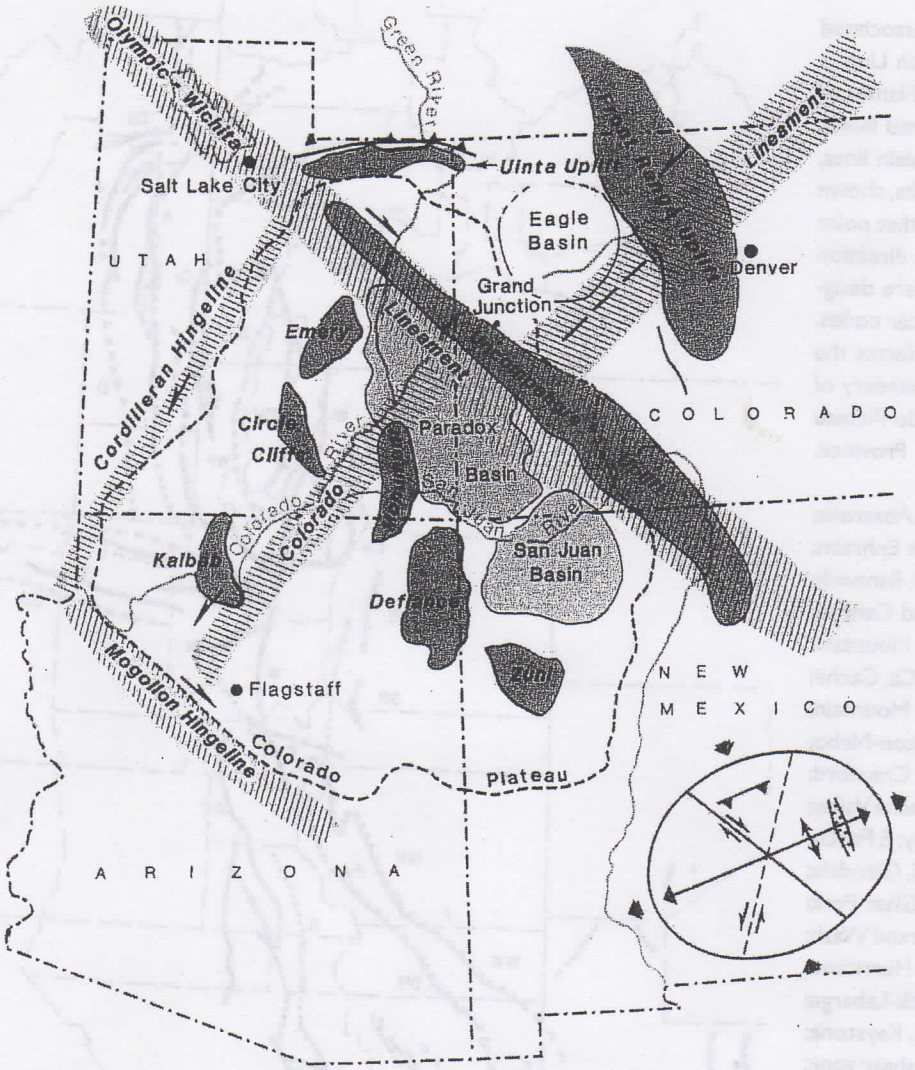

Figure 2. The Colorado Plateau and its relation to the major fault zones that define the province. Major geologic uplifts are shaded for easy orientation. From Baars and Stevenson 1982.

The geologically simplified Colorado Plateau Province is bounded by basement fault zones as just described. The southern boundary of the province lies adjacent to a fracture zone known as the Texas Lineament, or the Mogollon Hingeline (Figure 2). The fracture zone apparently extends northwestward through Nevada, forming the eastern margin of the Sierra Nevada. Topographically, the fault zone bounds the margin of relatively flat-lying sedimentary rocks, called the Mogollon Rim. Along this topographic break are several volcanic features, such as the White Mountains and San Francisco Volcanic Field, and numerous volcanic cinder cones and lava flows of Tertiary to Recent origin. South of the Mogollon Rim are numerous fault-bounded mountain ranges that consist of Precambrian crystalline basement rocks and much-thickened sections of Paleozoic and Mesozoic rocks (see time scale in Figure 5).

The western border of the Colorado Plateau lies generally along the

Wasatch Line, or the Cordilleran Hingeline (see Figure 3). This significant trend may have been the western edge of the North American continent, formed by rifting and sagging of a former landmass to the west in Late Precambrian time. Along the broad fault zone, 50 to 100 miles wide, are drastic changes in thickness of Paleozoic and early Mesozoic strata. Layered rock units to the east may range from a few hundred to a couple of thousand feet thick, as compared with several thousand feet to the west in the Great Basin, or Basin and Range Province. West of the Wasatch Line are numerous mountain ranges and intervening basins, whereas east of the line are relatively flat-lying sedimentary and volcanic rocks. Surface faults of relatively recent age, Tertiary, occur along the Wasatch Line, bounding the various units of the High Plateaus Subprovince (see Figure 3). These Tertiary-age faults bound several high plateaus, such as the Paunsagunt, Pavant, Sevier, Toroweap, and Wasatch. Many are capped by volcanic rocks of Tertiary age. Thick fault-bounded deposits of salt and gypsum mark the transition zone.

The Wasatch Line is interrupted in north-central Utah by the Uinta Mountains, a maverick east-west-trending mountain range along the Utah-Wyoming border. These high, rugged mountains are composed of a core of Late Precambrian quartzitic rocks along the crest of a monstrous upfold (anticline) bounded on either flank by thrust faults. Because of topographic considerations, the Uinta Mountains constitute a well-defined northern boundary of the Colorado Plateau Province.

The eastern edge is the most arbitrary and most manipulated boundary of the Colorado Plateau Province. If we consider the Uinta Basin, south of the Uinta Mountains, to be part of the Colorado Plateau, then the northwest-trending basement highland, the Uncompahgre Uplift, would best define the eastern boundary in northwestern Colorado. But then what? If we consider the San Juan Mountains of southwestern Colorado to belong to the Southern Rocky Mountains (see Figure 4), as do many authors, then an arbitrary line must be drawn from the southern Uncompahgre Uplift to the northern edge of the San Juan Mountains. Certainly, the San Juan Mountains are truly mountains, sometimes called the American Alps, but their geology is much more closely related to Colorado Plateau geology than to that of the Southern Rockies. I have previously included the San Juans as part of the Colorado Plateau, but in this case we will follow conformity and exclude this beautiful and significant mountain range. From there, the southeastern boundary most likely should follow a prominent fault zone, apparent both in the Precambrian basement and at the surface: the Rio Grande Rift and related components.

The Rio Grande Rift is a very noticeable faulted valley system that extends from south of Albuquerque, New Mexico, northward into west-

central Colorado. The broad valleys resulted from north-south faulting that extended, or pulled apart, a zone in the earth's crust. The rift has been documented as active for the past 17 million years or so, but there is substantial evidence that it was active even during Paleozoic time and probably originated in Precambrian time. The margin of the Colorado Plateau is usually placed along the Nacimiento Mountains (see Figure 4), an active segment of the rift system in Paleozoic time.

From about Socorro, New Mexico, toward the southwest, one must use considerable imagination to connect the Rio Grand Rift to the White Mountains volcanic field, and thus the Mogollon Hingeline, completing the circuitous boundaries of the Colorado Plateau. This imaginary line must be drawn such that the Zuni Uplift of northwestern New Mexico is separated from the fault-bounded basin ranges of west-central New Mexico. This southeastern margin of the plateau is somewhat evasive, lying along a trend of volcanic features and mineralized zones called the Jemez (pronounced *hey! mess*) Lineament.