

portable events in Florida have been recorded since that time. Beginning in 1989, the Gainesville station was upgraded with three-dimensional short-period and long-period digital instruments, and remote stations were installed in the Everglades, Sarasota County, Wakulla Springs, and Waycross, Georgia.

#### ORIGIN OF FLORIDA EARTHQUAKES

Seismic activity in any area can be attributed to stress accumulation and release, usually related to displacement on active faults, or to isostatic imbalances requiring adjustment. Correspondingly, low levels of seismicity are an indicator of tectonic stability. Lithospheric plate margins and well-studied intraplate flexural features (e.g., New Madrid fault zone) are too far removed from the Florida Platform to be a source of crustal stress. Indeed, there is no evidence for active faulting or deformation in Florida during the Holocene Epoch, and probably for most of the Neogene. However, Long (1974) has suggested that Florida earthquakes may occur along extensions of crustal block edges where irregularities of crustal structure and differential vertical uplift can amplify stresses. Seismicity maps for the U.S. (e.g., Stover 1986) and for the southeastern U.S. (Bollinger 1973; SEUSSN Contributors 1992) demonstrate a seismic quiescence for Florida and suggest an abrupt decrease of seismicity south of a proposed suture zone linking Appalachian basement with a more stable Gondwana basement (Lord and Smith 1991). Only three of the five events listed in

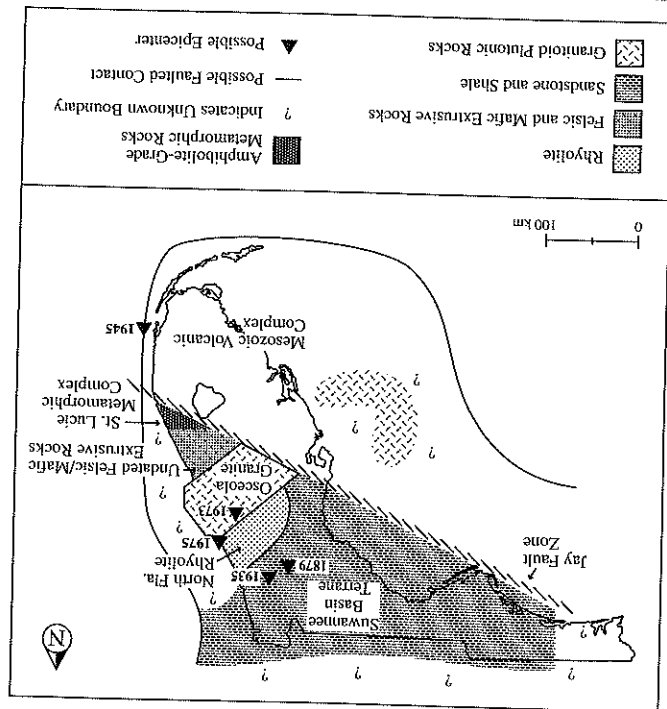


Figure 2.9. Probable epicenters for earthquake events listed in table 2.1 and their relationships to major subsurface features.

#### Seismicity

The Florida Platform is characterized by a unique seismicologic stability that has yielded very few confirmable earthquakes. Although many historical events have been reported as earthquakes in Florida, and some descriptions conclusively suggest actual earthquakes, no damaging events are known to have occurred within the state. An early compilation (Campbell 1943) of reported Florida earthquakes cited fifteen dates and estimated intensity values based on newspaper accounts, weather-bureau records, and private accounts or files; however, most of the reported events are associated with vague locations, uncertain or conflicting times, and obvious confusion with publicized events beyond Florida. An expanded report of Florida earthquakes (Mott 1983) listed thirty-three events beginning in 1727, but conceded that many may be events that occurred outside the state. In the early nineteenth century, the population of Florida was less than 35,000 and was concentrated in the St. Augustine and Apalachicola River areas. Accordingly, the initial geographic pattern of reported events was limited to those areas, and gradually expanded to mimic the distribution of the growing population.

Reagor et al. (1987) included Mott's and other data in a comprehensive review of earthquake reports and a seismicity map of Florida. Estimated intensities were assigned to each reported event, and estimated magnitudes (3.5 and 2.9) were assigned to the most recent events (Merritt Island in 1973 and Daytona in 1975, respectively). However, many of the reports can be attributed to blasting, military activities, and other non-seismic phenomena. A critical review of all seismic data for Florida (Smith and Randazzo 1989) identified only six events from 1879 to 1975 that could be accepted as possible earthquakes. Subsequent reviews have reduced the number of plausible events to five (table 2.1; fig. 2.9). Although the 1973 and the 1975 events each were felt throughout a large local area, they were recorded only by seismograph stations outside the state. Consequently, a single component seismograph station (GAI) was installed in Gainesville in 1977 (Smith 1978), and no re-

Table 2.1. Seismic events in Florida attributed to a tectonic origin

| Date             | Location   |
|------------------|--|
| 13 January 1879  | Uncertain; felt throughout north Florida and South Georgia |
| 14 November 1935 | Palatka  |
| 22 December 1945 | Offshore Miami   |
| 27 October 1973  | Merritt Island   |
| 4 December 1975  | Daytona  |

Note: Exact locations shown in fig. 2.9.

table 2.1 (1935, 1973, 1975) are well located. The 1945 event has credible newspaper documentation, but a poor epicenter determination; it coincided with a recording at a seismic station in Alabama, but no clear association could be established (Mott 1983). Early newspaper accounts of the 1879 event suggest its authenticity, but an exact epicenter cannot be identified, and the event could have originated within a wide area in northern peninsular Florida or southern Georgia.

Figure 2.9 locates probable epicenters of the five identified events, and shows their relationships to basement features. None of the events appear to be definitively associated with the Jay Fault or with the Tallahassee Graben boundaries, and those features must be regarded as substantially stable. Continued subtle tectonic adjustments within the Osceola complex are plausible, and are the probable sources of the few Florida earthquakes.

### Geothermal State of the Basement

Early summaries of subsurface thermal conditions in Florida were based on interpretations of uncorrected bottom-hole temperatures recorded in boreholes during or shortly after drilling activity. Using bottom-hole temperatures from approximately 300 boreholes, Griffin et al. (1969) and Reel and Griffin (1971) developed a geothermal gradient map of Florida with the purpose of defining areas potentially favorable for oil and gas maturation. Their map (fig. 2.10) identified subsurface temperature gradients that range from approximately 27° C/km in the western panhandle to 13.5° C/km in the southern peninsula, and even lower in the Keys.

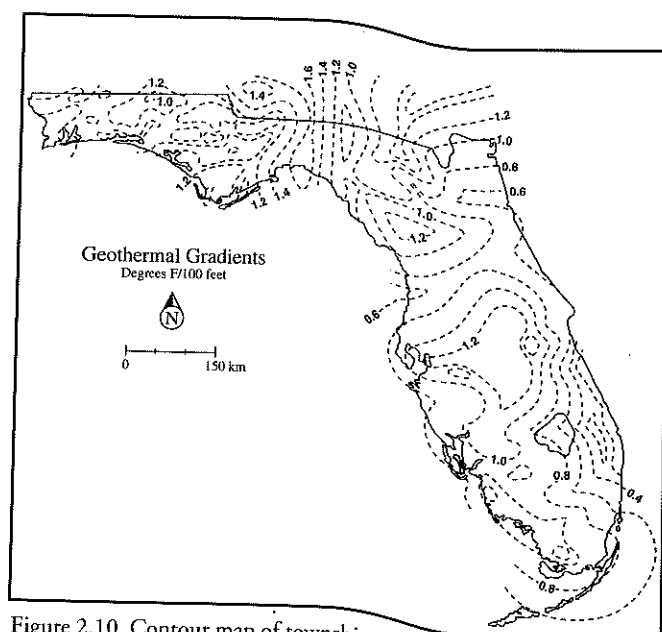


Figure 2.10. Contour map of township averages of geothermal gradients in Florida and south Georgia (Reel and Griffin 1971).

Temperature values from oil well test holes also were used by Kohout (1967), Henry and Kohout (1972), and Kohout et al. (1977) to demonstrate a negative thermal gradient in the lower part of the Floridan aquifer in southern Florida. They proposed a "normal" geothermal gradient of approximately 20° C/km below the aquifer system, but described a lateral extraction of heat by an influx of cold seawater circulating into the aquifer system.

Using bottom-hole temperatures and estimates of thermal conductivity, Reel (1970) and Griffin et al. (1977) calculated heat flow values for Franklin County and Palm Beach County. These estimates were similar to values computed from measured temperatures in equilibrated boreholes, and to laboratory determinations of thermal conductivity presented by King and Simmons (1972), Fuller (1976), and Smith and Fuller (1977). Ten new heat flow values, mostly from the western panhandle, were published by Smith et al. (1981a), Smith et al. (1981b), and Smith and Dees (1982). Figure 2.11 is a summary of all the heat flow values determined for Florida.

In general, heat flow in Florida is relatively low, ranging from 64 mW/m<sup>2</sup> in the panhandle to 20 mW/m<sup>2</sup> or less near the northeast coast and in the north-central highlands. Most of the higher values were recorded in the western panhandle, which is consistent with the observation (Smith and Dees 1982) that heat flow along the Gulf Coastal Plain increases from east to west. High thermal gradients (31 to 34° C/km) were detected in limited segments of boreholes in the Pensacola area. The highest actual temperatures (approximately 35°

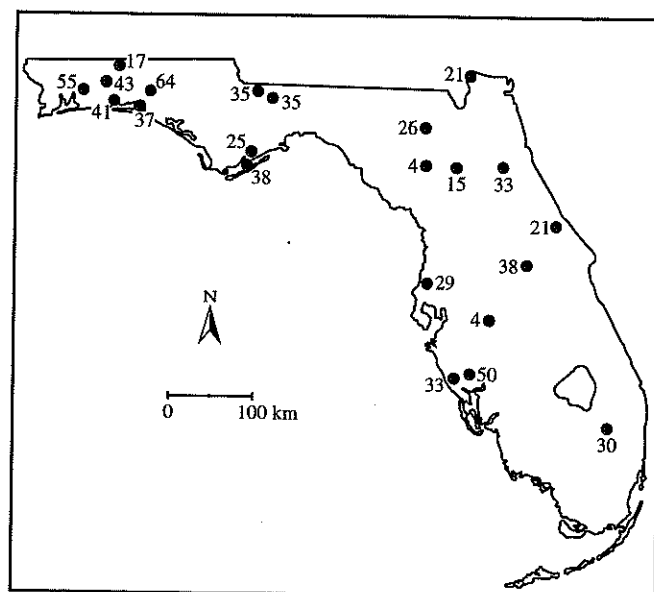


Figure 2.11. Heat-flow values (in mW/m<sup>2</sup>) determined from measurements and estimates in Florida. Data from sources cited in text.