

and lower. The commonly monitored waves of higher frequencies are usually produced, according to plate tectonics theorists, when the relative plate movements somehow stick, releasing the tension in jerky spasms. The smoother movements produce the low-frequency waves.

Further evidence in Japan shows up in measurements by Caltech geophysicist Kunihiko Shimazaki, who has found that crustal tilting and lifting in northern Japan can account for only 20 percent of the known plate slip. Somehow, he believes, the Pacific plate is creeping under the Asiatic one without deforming.

Off the Alaskan coast, the repeat time is not definitely known, although 1,000 years has been suggested, during which time plate subduction amounts to about 120 feet. The Alaskan quake of 1964 involved 30 to 60 feet of displacement, only a fourth to a half of the total if the

1,000-year repeat time is correct. The San Andreas fault in California also shows gradual, non-quake-related creep, but the repeat time for quakes along the fault is not known, says Kanamori, so the "silent quake" theory cannot yet be evaluated.

One of the major implications of Kanamori's work is for predictions of tsunami, or tidal waves. Sometimes, he says, a quake can appear small on the Richter scale, which incorporates only higher-frequency measurements, yet have a total energy that is very large. An 1896 quake at Sanriku, Japan, for example, produced only minor shaking, but it was accompanied by one of the most devastating tsunamis ever to strike the country. Realization of the danger of low-frequency, "silent" quakes, Kanamori says, should be incorporated into tsunami warning systems, which at present are based largely on Richter-type measurements of earthquake magnitude. □

## Washington's era of Metro begins



Spacious stations, comfortable rides greeted Washington Metro's first passengers.

When ground was broken in 1969 for beginning construction on Washington, D.C.'s, metropolitan rapid transit system, Metro, then-President Nixon expressed a common hope of planners trying to stem decay of the nation's capital: "More than a subway will begin . . . a city will begin to renew itself, a metropolitan area to pull itself together." Thus, with the opening this week of the first 4.6-mile segment of Metro, one of the boldest urban renewal experiments ever attempted got underway.

The urgent need for something to halt the spread of squalor has long been apparent. A study of the Metro idea, conducted by Development Research Associates, concluded that Washington might benefit more from such a project than any other metropolitan area in the United States. The report showed the city to be "ideally suited for rapid rail transit," with a strong downtown, relatively compact

suburbs and high transit ridership.

The initial line—less than five percent of the projected system—will hardly make a dent in the life of the capital, but Metro officials hope that its very attractiveness and success will spur local governments to raise the money needed to complete the rest. Estimated costs have soared from \$2.5 billion at the start to \$4.67 billion currently. Some suburban governments are considering pulling out of the cooperative effort, construction is limping along on federal funds left over from highway projects, and overall progress has been held up by strikes, storms, management problems and lawsuits.

Despite inevitable start-up problems, opening day was generally a success, with more than 50,000 people showing up for free rides. They were treated to the fastest, most comfortable journey in town—once technicians could get all the train doors

closed, a task that once took up to 40 minutes. (Heavy loads apparently buckle the cars just enough to jam the doors.) The cars have carpeting, plush, two-inch-thick padded seats (though some will have to be replaced because of potential fire hazard), year-round air conditioning (which also needs to be tinkered with) and steel wheels well suspended for a smooth, silent ride (though the brakes must be adjusted so they don't jam under heavy loads). Most problems had been worked out by the time the first paying passengers rode on Monday, in numbers twice as high as expected.

Underground stations are built inside long, continuous arches, indented like wrap-around waffles for noise suppression. Platforms are set away from walls to prevent vandalism and have been cleared of pillars and hiding places that could invite muggers. The whole effect, in the words of one architecture critic, is "a serene kind of beauty."

To cut down noise to surrounding areas, tracks along some segments are supported on pads that absorb the vibration of passing trains. Tracks are also welded, so there is no "clickity-clack." In particularly sensitive areas, the whole concrete track platform is suspended to keep noise from disturbing people in buildings above. Inside the subway cars, sound levels are about the same as in a good automobile, except for moaning brakes.

Already one can begin to see improvement in neighborhoods bordering on prospective Metro lines, and the system is eventually expected to return \$3 for every \$1 invested, including increased property taxes. (In Toronto, a 4.5-mile system costing only \$67 million sparked a \$10 billion building program.) But the overall impact of Metro on the life of the community will depend on how much of the proposed system is eventually finished. At present, about half the planned 99.8-mile system is under construction or completed, including 42 of 87 proposed stations.

Commuters can begin to take advantage of the new rapid transit—supposedly about four times faster than a taxi—by driving to the only above-ground station along the new line. There a parking lot and "kiss and ride" area (drop-off point for commuters) have been provided; later a complete rerouting of bus lines will provide an integrated system of area-wide transportation. The next section of line is scheduled to open next year, which will include service to National Airport.

Meanwhile, this summer's expected flood of tourists may not find Metro too helpful: As they board at the Union Station Bicentennial Center, the new line can only take them into a nondescript Northeast neighborhood or across to the bustling commercial district—bypassing the Mall and popular monuments. Still, come July, Metro may be one of the safest, most comfortable places in town. □