Colored areas are underlain by saturated alluvial deposits that form the main ground-water reservoir. Uncolored areas are underlain by rocks that contain only small amounts of recoverable ground water; data are currently inadequate to define velocities and directions of movement of ground water in these areas

Average ground-water velocity is inferred to range between 1 and 10 feet (0.3 to 3 meters) per year

Average ground-water velocity is inferred to range between 10 and 100 feet (3 to 30 meters) per year

Average ground-water velocity is inferred to range between 100 and 1,000 feet (30 to 300 meters) per year

Average ground-water velocity is inferred to range between 1,000 and 10,000 feet (300 to 3,000 meters) per year

Area where significant changes in water-level gradients seem reasonably likely during 1972–78; where significant changes occur, the ground-water flow directions and velocity will change

Flow path indicating direction of ground-water movement

Estimates of the average velocities at which ground water moves through the uppermost few feet of saturated alluvial deposits of the Tucson area are shown on the map. Arrows show representative directions of ground-water movement; the estimated average velocity of movement is indicated by color. The estimated ground-water velocities in the uppermost alluvial deposits of the Tucson area range from about 1 to nearly 10,000 feet (0.3 to 3,000 meters) per year. The lowest velocities occur where the permeability of the alluvial deposits is low or where water-level gradients are low. The highest velocities are found where water can move through coarse stream-channel alluvial deposits. Ground-water velocities along Santa Cruz River and Nogales Wash above their confluence are estimated to be greater than 6,000 feet (1,800 meters) per year. From the confluence downstream to about the town of Continental velocities probably decrease to less than 1,500 feet (460 meters) per year. Most other areas shown in the highest velocity zone have ground-water movements estimated to range between 1,000 and 1,500 feet (300 to 460 meters) per year. All velocity estimates shown are for the upper few feet of saturated deposits because it is assumed that most ground-water contamination by man will occur at or near the surface.

The map is based on water-level data collected mainly during 1970–72, permeabilities estimated from aquifer tests and grain-size analyses, and estimated and measured porosities. Most of these data were collected from wells penetrating 200 feet (60 meters) or more of saturated alluvial deposits. Because the upper few feet of the saturated deposits, where tested, generally have a higher permeability and porosity, the data were subjectively extrapolated to the upper few feet of saturation. Average velocities were calculated using a form of Darcy's law: $V = PI/n$, where V is the average velocity of ground-water movement in feet per day (meters per day), P is the permeability of the alluvial deposits through which the water flows in gallons per day per square foot under a hydraulic gradient of 1 foot per foot (cubic meters per day per square meter under a hydraulic gradient of 1 meter per meter), I is the water-level gradient in feet per foot (meters per meter), and n is the porosity of the alluvial deposits, a decimal fraction. The velocities in some parts of the area may be substantially in error because of errors in estimates of permeability and porosity; in addition, if water-level gradients significantly change due to extensive pumping of ground water, flow directions and velocities will change. The map can be used to estimate average ground-water velocity as long as the values used in the formula do not change. For areas where heavy pumping is causing changes in the water-level gradients, such as the Tucson and Santa Cruz Flats areas, the map may be inaccurate within a few years of 1972; elsewhere the map might be reasonably accurate for many decades. Areas where significant disruptions in water-level gradients seem most probable within the next few years are stippled on the map.
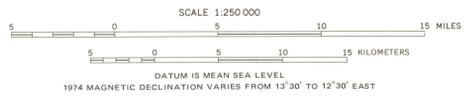
The map can be used to indicate the direction and maximum speed with which a pollutant or contaminant might travel if introduced into the uppermost few feet of saturated alluvial deposits. (Owing to dispersion or attenuation due to adsorption on clay particles, many contaminants will travel at an effective rate slower than that of the ground water.) For example, if a hypothetical contaminant were added to the ground water about 5 miles or 8 km (kilometers) south of the town of Continental (see accompanying inset map), it would travel about 7 miles (11 km) before reaching a point east of Green Valley. Because the contaminant would travel about 2 miles (3 km) through a part of the 10 to 100 feet (3 to 30 meters) per year zone that is adjacent to a higher velocity zone, it is estimated that the speed through this part would be 80 feet (24 meters) per year. Through the 1½ miles (2½ km) of the 100 to 1,000 feet (30 to 300 meters) per year zone, the average speed is estimated to be about 500 feet (150 meters) per year. The contaminant would then travel through a part of the 1,000 to 10,000 feet (300 to 3,000 meters) per year zone; an average velocity of 1,200 feet (370 meters) per year is estimated for these final 3½ miles (5½ km) to the point east of Green Valley. Using these figures, the calculated times for the contaminant to move through the three parts of the flow line are, respectively, 130, 16, and 15 years. It should be noted, however, that the possible error could be as great as 100 percent for any of these estimates.
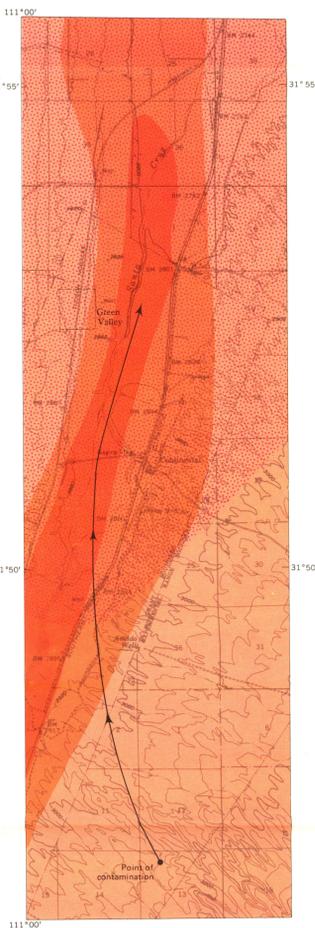
INSET MAP

Base from U.S. Geological Survey
Tucson 1946–57

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

Base from U.S. Geological Survey
Ajo 1953–69, Tucson and Nogales 1956–62

SCALE 1:250 000

DATUM IS MEAN SEA LEVEL
1974 MAGNETIC DECLINATION VARIES FROM 13°30' TO 12°30' EAST

MAP SHOWING GROUND-WATER VELOCITIES IN THE UPPERMOST SATURATED ALLUVIAL DEPOSITS OF THE TUCSON AREA, ARIZONA

By

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1974