SOLAR ECLIPSE

MARCH 7, 1970

TOTAL SOLAR ECLIPSE, MARCH 7, 1970

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I. Occurrence of the eclipse. (Note: in this information sheet, the word eclipse will refer to only solar eclipses; there are also lunar eclipses.)

1. Partial eclipse at Greenville begins: 12:14:05 PM; totality begins 1:31:51; totality ends 1:34:48; partial ends 2:48:56 PM, all EST.
2. In North Carolina, the center of totality passes near Elizabethtown, LaGrange, Greenville, Williamston, and Windsor. NW edge of totality passes near Laurinburg, Clayton, Nashville, and Halifax. SE edge near S. C. line at ocean, Leland (5 miles W of Wilmington), Jacksonville, New Bern, Pamlico Beach, and East Lake. Path of totality about 85 miles wide. Eclipse advances 37 miles per minute.
3. Magnitude of eclipse at several non-total cities (N. C. except as noted): Wilmington .998; Morehead City .99; Columbia, S. C. .99; Charlotte .96; Greensboro .96; Burlington .97; Durham .98; Raleigh .99; Petersburg, Va. .98; Charlottesville, Va. .94; Washington, D. C. .95.
4. Totality path enters USA near Perry, Florida; grazes Tallahassee, passes along the coast of Georgia, South and North Carolina, leaves land at Virginia Beach, passes coastal Nova Scotia and Newfoundland. The eclipse will be visible as at least partial in nearly all the USA.

II. Rarity of total eclipses; four in USA in 50 years

1. The last total eclipse seen in North Carolina was on May 28, 1900; an eclipse of major importance.
2. Other totalities in USA since 1950 are June 30, 1954, Minnesota; and July 20, 1963, Maine.
3. The only remaining total eclipse for mainland USA in the twentieth century is February 26, 1979, State of Washington.
4. In all the British Isles in 1400 years, there have been only 18 total eclipses. In the same fourteen centuries there have been only two total eclipses for London; this is less than average, which is an expectancy of one totality in 360 years.

III. Features of a total eclipse

1. Duration of total eclipses is from zero to 7 minutes 31 seconds. The shadow moves generally eastward (but usually toward NE to SE) at speeds between 16 to 100 miles per minute. In the USA, ours is moving NE.
2. The width of totality of different eclipses ranges from zero to 163 miles. This one ranges from 97 in Mexico to 70 in Newfoundland.

3. The skies will become dark so that only the headlines of a newspaper can be read. Cattle and chickens are expected to prepare for night. First magnitude stars Deneb and Capella should be visible, the former in the west and the latter in the east, each almost half way to the zenith. Venus will be seen about four finger-widths east of the eclipsed Sun, and Mercury about twice as far to the west. Mars and Saturn are much farther eastward on the eastern edge of Pisces, about ESE.
4. Bailey's beads are perhaps the most spectacular view during a total eclipse. Just as the Moon covers, or uncovers the disk of the Sun there appears to be a thread of the Sun's circumference and this thread has irregularly spaced beads as the Sun's light passes through valleys between mountains at the Moon's edge. Sometimes there will be a single brilliant bead, and the phenomenon is called the "diamond ring." Due to libration of the Moon and to angle of approach, the phenomenon of Bailey's beads is different for various eclipses. For this eclipse, the beads will not be prominent at beginning of totality, but should be seen at the end of totality.
5. Perhaps the most dramatic phenomenon of a total eclipse is the red flash, lasting only a "second." This is the result of the Moon covering the Sun's disk, but not the chromosphere. At that instant the brilliant red of hydrogen-alpha emission is seen. Presence of Bailey's beads is detrimental to the red flash. Helium was first discovered by study of the red flash spectrum in 1868, long before its discovery on Earth in 1895.
6. Preceding and following totality there is the appearance of dark and bright bands of light, with "wavelength" of inches or more. Reports on the speed of these bands differ widely from zero to some hundreds of feet per second. The bands are best seen on a white horizontal surface (a sheet, etc.). Snow is excellent. Orientation of the bands is generally parallel to the Sun's crescent.
7. The times of contacts of the eclipse (to tenths of seconds) are quite important to astronomers since they provide means for checking computed orbital values, masses, etc. The four contacts are: beginning of partial eclipse (Moon "contacts" Sun), beginning of total eclipse, end of total eclipse, end of partial eclipse. The last total eclipse was observed in Siberia, on September 22, 1968. On this occasion the time between second and third contact was 37 seconds rather than the expected 43 seconds.
8. Greatest scientific interest continues to be given to the Sun's corona. This is a very tenuous substance, a plasma (rarefied ionized gas), which surrounds the Sun extending outward irregularly to distances of perhaps several million miles. It is most uniform at times of maximum sunspot activity. March 7 will find the Sun past a period of sunspot maximum but still quite active, minimum activity expected in 1976. The corona will have a pearlish appearance and will give off about half as much light as the full moon. The temperature of the corona reaches 5,000,000 degrees. How this is possible is a present problem of science.

9. Great care must be taken in any observation of the Sun, and warning is especially appropriate regarding eclipses. Even a one second glance at the full Sun through binoculars will undoubtedly leave a person with permanent blindness in part of his field of vision. Also binoculars and other instruments may be damaged by concentration of heat onto cemented eyepiece lens.

IV. Circumstances for an eclipse

1. Since an eclipse is the falling of the Moon's shadow on the Earth, one can occur only at the instant of the new moon. Since the Moon is much smaller than the Sun, its shadow will consist of a long pointed black region (umbra) and a spreading gray region (penumbra). Total eclipse is within the umbra, partial is in the penumbra. The umbra varies in length from 228,000 to 244,000 miles varying as the distance to the Sun is from 91,500,000 miles to 94,500,000 miles. Since the distance from the near surface of Earth to the Moon varies from 218,000 to 248,000 miles it is seen that not all central eclipses will be total: many will leave a ring of the Sun exposed (annular).
2. The orbit of the Moon around Earth is inclined by 5.13^{o} from Earth's orbit around the Sun (ecliptic). Thus at times of new moon, the Moon may be above or below the ecliptic and its shadow will pass above or below Earth and no eclipse occur. The two intersections of Moon's orbit with ecliptic are called nodes. If the Moon and Sun are within 18.5 degrees of a node at the time of new moon, then an eclipse may (see below) occur somewhere on Earth, but if they are beyond that limit the shadow will pass above or below Earth, causing no eclipse.
3. Within a year, all eclipses (both solar and lunar) will occur in two (or three) seasons. These seasons are the times when the line between Earth and Sun passes near the ascending, or the descending, node where the Moon's orbit intersects the ecliptic. The possibility of the Moon's shadow falling on Earth depends on the inclination of these orbits, the size of the shadow, and the size of Earth. The Sun (and the Moon) must be within 18.5^{o} of a node in order to cause a partial eclipse under best conditions: Moon and Sun nearest Earth; and must be within 15.3^{o} under poorest conditions: Moon and Sun farthest thus providing a smaller shadow for a smaller (angular) Earth as target for the shadow. For a central eclipse (either total or annular), the Sun must be within 11.8^{o} of a node for best conditions, or 9.9^{o} for poorest conditions.
4. Since the Sun moves 0.986 degrees per day along the ecliptic, it will be within the "best conditions" limit 2×18.5^{o} for 38 days, and even for the poorest conditions for 31 days. But the Moon requires only 29.5 days to pass from new moon to new moon; hence there must be at least one, perhaps two, new moons within the 31 to 38 days, and therefore the same number of eclipses. It is this period of time which is called an eclipse season. But note that these limits are for partial eclipses. For central eclipses the number of days ranges from 20 to 24 days, and it is quite possible that an eclipse season may pass without a central eclipse. The time for the Sun to move from ascending to ascending node is 19 days less than a year, hence there can be two eclipse seasons and part of a third in one calendar year, and thus as

many as five and as few as two eclipses in one year. Perhaps none of these will be central, and if there is a central eclipse, it well may be annular instead of total. And if it be total it will be so for probably less than one half percent of the earth.

V. Saros eclipse families

1. Eclipses occur in families, the most notable of which are the Saros families of which there are now about sixty-five, with about fifteen noteworthy families currently having totalities. Eclipses of the same family occur at intervals of about 18 years 11.31 days. Thus if a total eclipse occurs on a given calendar day, there will be a similar eclipse 18 years later and 11 days later in the month (10 days later if five leap years have occurred). But the eclipse will be westward by nearly a third of the Earth's circumference. The eclipses will have strong similarities as to duration and paths.
2. Eclipses occur in Saros families because of the near equivalence of four periods of times:

19 eclipse years	= 6585.78 days	(1 eclipse year includes 2 eclipse seasons)
223 synodical months	= 6585.32 days	(new moon to new moon)
247 nodical months	= 6585.36 days	(Moon passes from rising node to rising node)
239 anomalistic months	= 6585.54 days	(time between Moon's nearest approaches to Earth)

The first three are responsible for the occurrence of the eclipse and its location on Earth. The fourth controls the size and duration of the eclipse as well as determining whether it be total or annular.

3. The first member of an eclipse family occurs near the north (or the south) pole, and successive ones are nearly 200 miles toward the other pole. Eclipses of the family will occur every 18 years 11 days for about 1300 years, until the last one, about 75th, will occur at the opposite pole. The family will consist of about 15 partial eclipses followed by about 45 central eclipses, and concluded by about 15 partial eclipses. The central eclipses will gradually go through a cycle of annular and total phases.

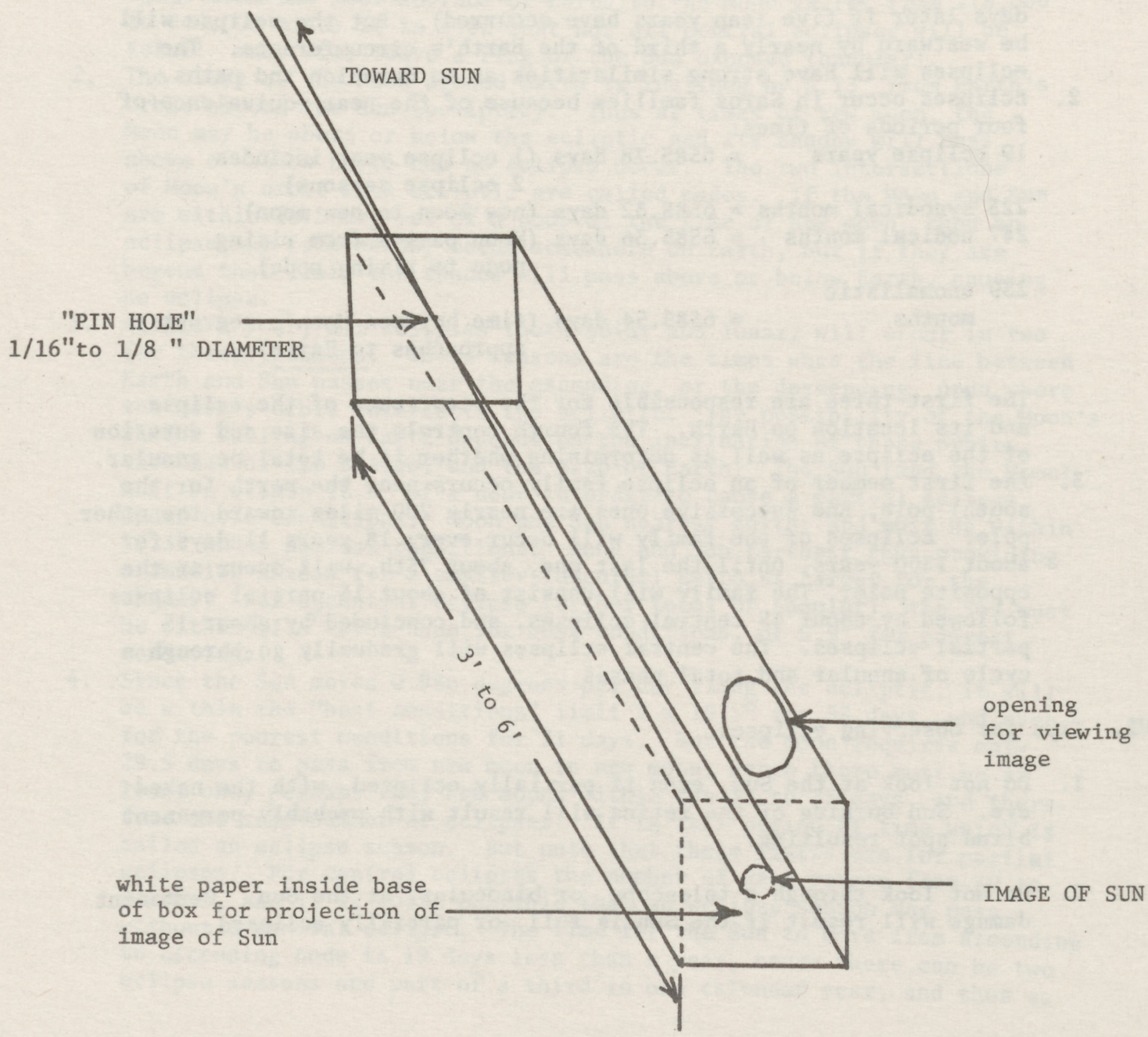
VI. Tips for observing eclipses

1. Do not look at the Sun, even if partially eclipsed, with the naked eye. Sun burning of the retina will result with probably permanent blind spot resulting.

2. Do not look through a telescope, or binocular, at the Sun. Permanent damage will result if the Sun is full, or partially eclipsed.

A pin-hole "camera" or "telescope" may be used, with image of the partially eclipsed Sun cast onto a screen. A "camera" made with a yard-long tube will produce solar image about a half an inch in diameter.

The diagram below shows a cardboard box or cardboard linoleum tube designed for safely viewing the image of the Sun during a solar eclipse:



THE MARCH 7, 1970 SOLAR TOTAL ECLIPSE IN NORTH CAROLINA

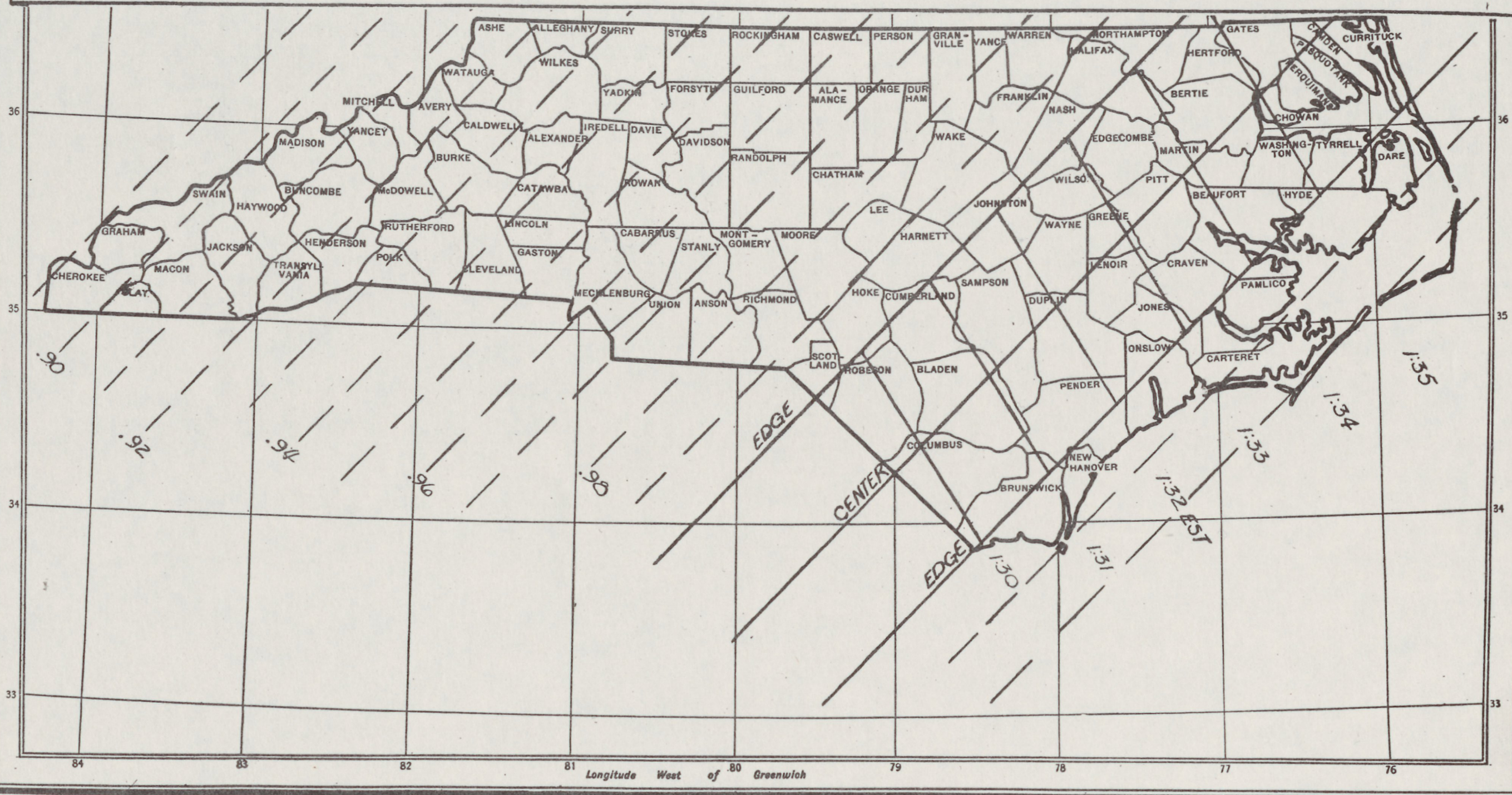
The path of the total eclipse is shown by solid lines: central line and edges.

Crossing the eclipse path are other solid lines which show, in one minute intervals, the time of the middle of totality at the positions of the lines. The time lines also represent the minor axis of the sheared elliptical projection of the Moon's shadow on the Earth's surface, the surface not being perpendicular to the line to the moon.

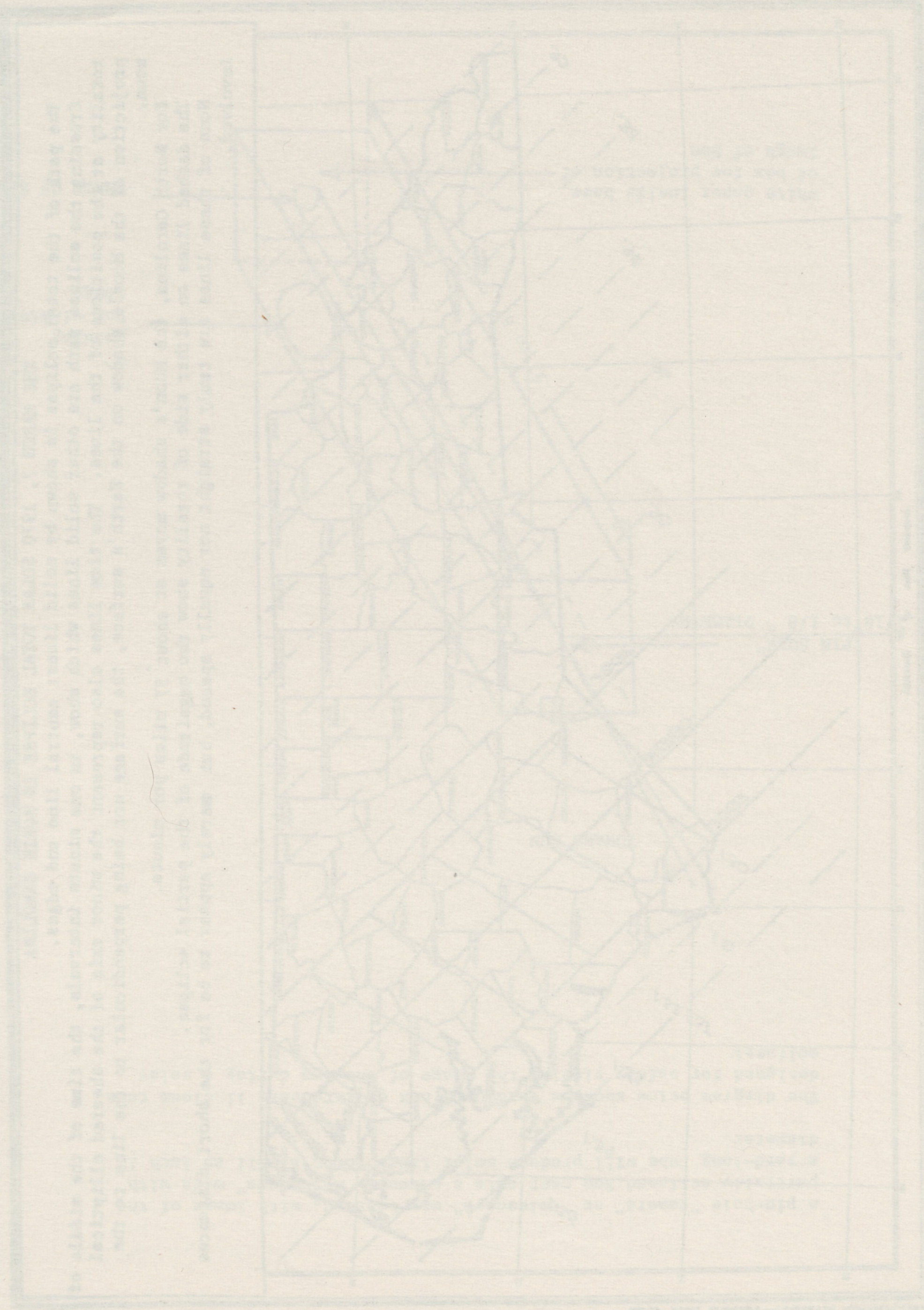
For North Carolina, the Moon's shadow moves at about 37 miles per minute.

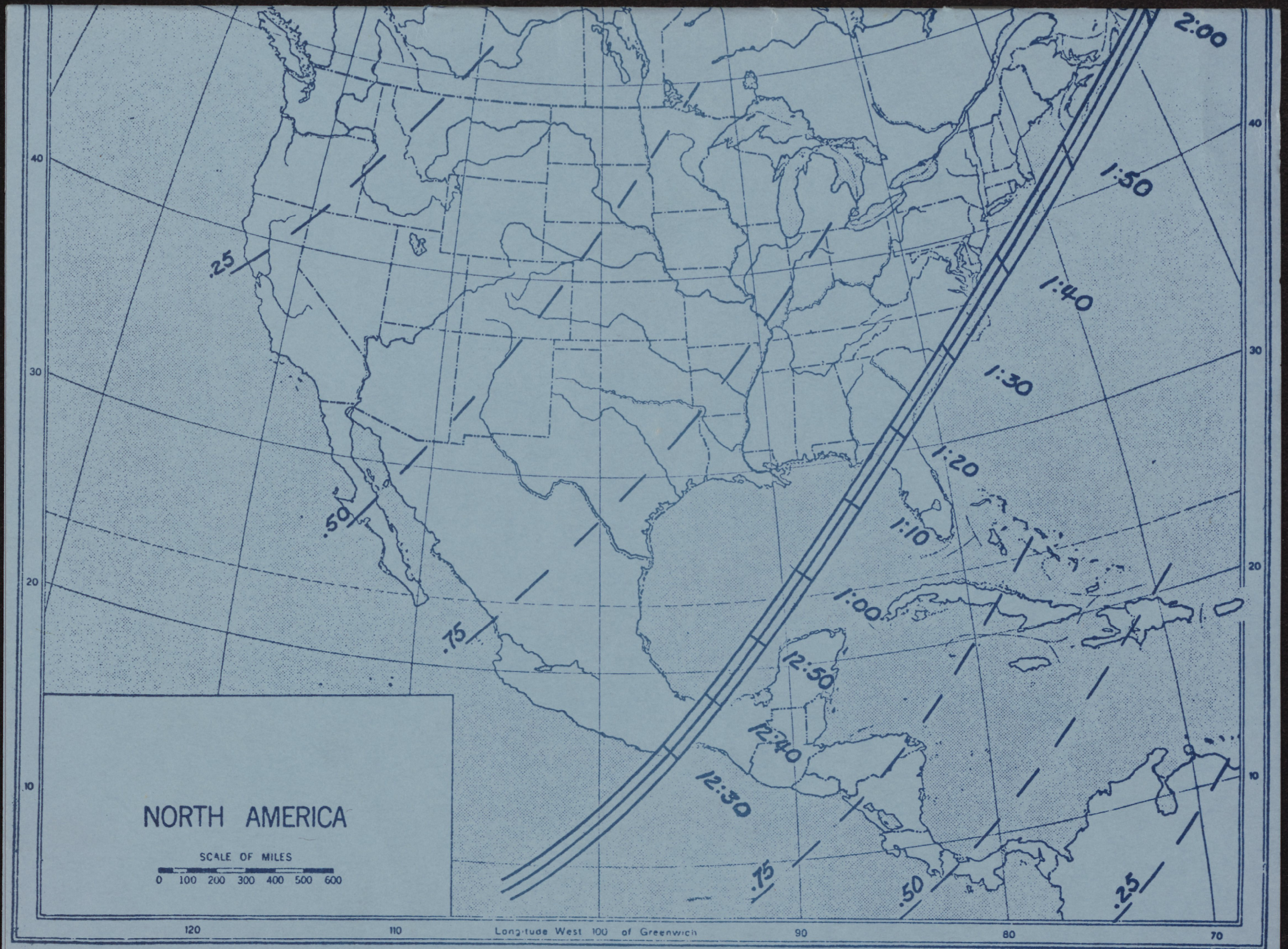
The dashed lines on either side of totality show the magnitude of the partial eclipse.

None of these lines are truly straight nor equally spaced, but merely appear to be for the short distances involved.



MAP NO. COSS1—NORTH CAROLINA

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NORTH AMERICA
SCALE OF MILES
0 100 200 300 400 500 600
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Longitude West 100 of Greenwich
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