GEODETIC MEASUREMENTS WITH A MOBILE VLBI SYSTEM*

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ABSTRACT

The Project ARIES 9-meter transportable antenna has been used as one element of a very long baseline interferometer (VLBI) to begin monitoring locations of six sites in California relative to large diameter fixed antennas at the NASA Deep Space Network, Goldstone, California, and at the Caltech Owens Valley Radio Observatory, Big Pine, California. An accuracy of about 6 cm in the horizontal components has been demonstrated by comparison with measurements of the National Geodetic Survey. The RMS scatter of the lengths of the baselines between any pair of antennas is about 3 cm except for the Goldstone-JPL (Pasadena) baseline. In the period August 1974 to August 1977 the length of this baseline increased by 15 ± 5 cm as JPL moved westward relative to Goldstone at the rate of 6 ± 2 cm/year. The baseline lengths are unaffected by the uncertainties of UT1, polar motion, and tropospheric water vapor, which are the limitations to present three-dimensional vector accuracies.

Initial demonstrations have been made with a highly mobile 3.7-m-diameter antenna, but marginal system sensitivity has limited the accuracy. Planned improvements such as a low-noise receiver and wide-band Mark III data system will provide baseline precisions of a few centimeters for about two sites per week beginning about summer 1981.

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ANALYSIS	INSTRUMENTATION	GEOPHYSICAL REQUIREMENTS
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Figure 1. ARIES project team.

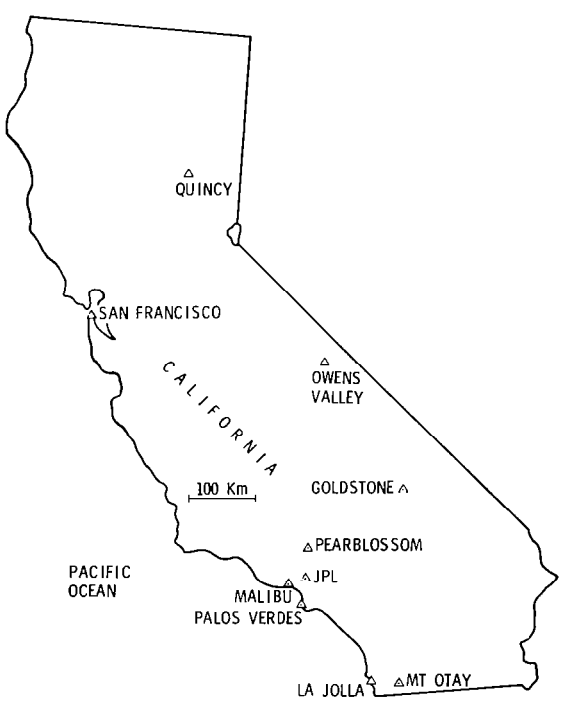

Figure 2. ARIES network.

STATIONS
- ARIES – 9m DIAM TRANSPORTABLE ANTENNA
- OVRO – 40m DIAM RADIO TELESCOPE - BIG PINE, CALIFORNIA
- DSS-13 – 26M DIAM } NASA DSN ANTENNAS - GOLDSTONE, CALIFORNIA
- DSS-14 – 64m DIAM }

FREQUENCIES
- S-BAND: 2.3 GHz – 40 OR 80 MHz BANDWIDTH SYNTHESIS
- X-BAND: 8.4 GHz – 80 MHz BANDWIDTH SYNTHESIS

FREQUENCY AND TIME REFERENCE
- HYDROGEN MASERS USUALLY
- RUBIDIUM CLOCK WHEN MASER NOT AVAILABLE

TROPOSPHERE CALIBRATION
- DRY COMPONENT – SURFACE PRESSURE AND TEMPERATURE
- WET COMPONENT – WATER VAPOR RADIOMETER OR SURFACE MEASUREMENTS

PHASE CALIBRATOR – NOT USED

Figure 3. Instrumentation ARIES VLBI network.

UNCERTAINTIES WITHIN INDIVIDUAL EXPERIMENT (~24 HOURS)		
• DELAY MEASUREMENT UNCERTAINTY	–	30-500 PICOSEC (1-15 CM)
• SOURCE POSITIONS	–	0.03-0.1 APRIORI
• TROPOSPHERE CALIBRATION	–	$\leqslant$6 CM PER OBSERVATION (IMPLICIT IN x^2 ADJUSTMENT)
• CLOCK DIFFERENCE MODELLING	–	$\leqslant$3 CM (IMPLICIT IN x^2 ADJUSTMENT)
SYSTEMATIC ERRORS FOR EACH EXPERIMENT		
• EARTH ROTATION PARAMETERS	–	~2 CM PER 100 KM
• USE OF GREEN BOOK FOR NUTATION, PRECESSION	–	~1 CM PER 100 KM
• TROPOSPHERE BIAS	–	~5 CM (LOCAL VERTICAL)
• LOCATION OF TRANSPORTABLE ANTENNA	–	$<$1 CM
UNMODELLED EFFECTS		
• EARTH TIDES AND OCEAN LOADING	–	$\leqslant$3 CM ($<$1 CM FOR 24 HOURS)
• IONOSPHERE	–	$<$2 CM (1977)
• PLANETARY PERTURBATIONS ON EARTH'S VELOCITY	–	~1 CM PER 100 KM
• GRAVITATIONAL BENDING	–	?

Figure 4. Error sources ARIES VLBI network ($B_L \leqslant 500$ km).

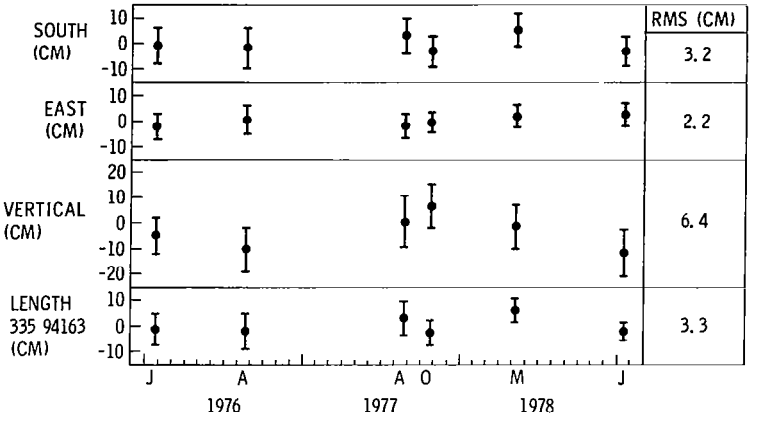

Figure 5. OVRO/ARIES (JPL) baseline vector. Relative local coordinates at JPL; OVRO assumed fixed. UT1: BIH; polar motion: NSWC (Doppler).

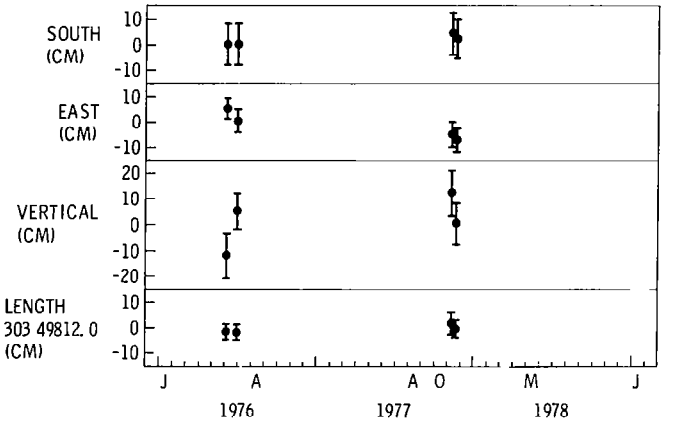

Figure 6. OVRO/ARIES (Pearblossom) baseline vector. (Relative local coordinates at Pearblossom; OVRO assumed fixed.) UT1: BIH; polar motion: NSWC (Doppler).

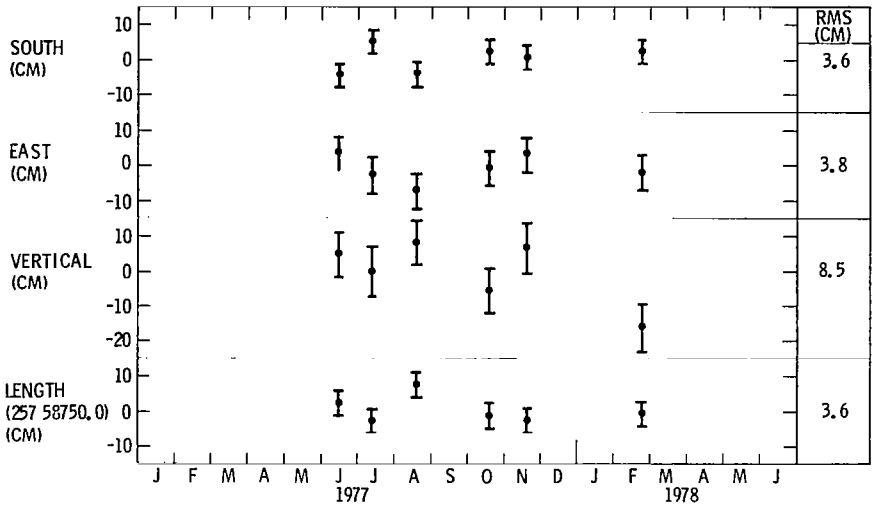

Figure 7. Goldstone (DSS-13)/OVRO baseline vector. (Relative local coordinates at OVRO; DSS-13 assumed fixed.) UT1: BIH; polar motion: NSWC (Doppler).

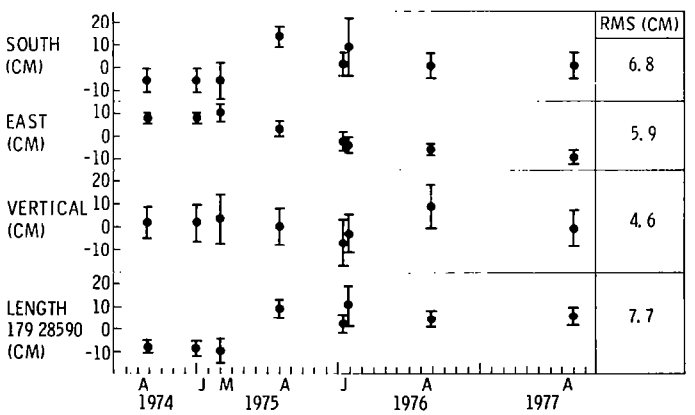

Figure 8. Goldstone (DSS-14/ARIES (JPL) baseline vector. (Relative local coordinates at JPL; DSS-14 assumed fixed.) UT1: BIH; polar motion: NSWC (Doppler).

- FREQUENCY DISTRIBUTION SYSTEM STABILITY/ CALIBRATION
- TROPOSPHERE CALIBRATION
- EARTH ORIENTATION PARAMETERS

Figure 9. Major challenges.