RESTORATION OF APOLLO MAGNETIC FIELD DATA: ACCOMPLISHMENTS AND OUTSTANDING ISSUES. P. J. Chi[1], C. T. Russell[1], D. R. Williams[2], and H. K. Hills[3], [1]Institute of Geophysics and Planetary Physics, UCLA, Box 951567, Los Angeles, CA 90095-1567; pchi@igpp.ucla.edu, [2]National Space Science Data Center, Code 690.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771, [3]ADNET Inc., NSSDC Code 690.1, NASA Goddard Space Flight Center, Greenbelt, MD 20771.

Introduction: In addition to other achievements, the Apollo missions collected a unique set of lunar magnetic field measurements. In particular the Apollo 15 and 16 missions enabled the only coordinated observation of its kind by deploying both the Apollo Lunar Surface Experiment Packages (ALSEP) and the Moon-orbiting subsatellites. The joint magnetic field observations on and above the lunar surface provide valuable information about the interaction between the solar wind or the magnetotail and the interior conductivity structure of the Moon.

The Apollo magnetic field data were examined in earnest in the 1970s, but since then they have not been widely used. The major obstacle to study these data at the present time is that the digital data are stored in obsolete forms which make them inaccessible to most users. Our objective is to make available these data in formats easily used in today's computing environment.

Data Sets and Restoration Efforts: The deep archive of Apollo magnetic field data consists of 44 magnetic tapes residing at the National Space Science Data Center (NSSDC). We have received from NSSDC a copy of all the digital data with the highest temporal resolution, including the 0.3-s Lunar Surface Magnetometer (LSM) data and the 24-s Subsatellite Biaxial Magnetometer (SBM) data that exceed 3 Gigabytes in volume. The LSM data are triaxial magnetic field measurements in the ALSEP coordinates. The SBM data contain the magnetic field along the spin axis and in the spin plane, relevant engineering and processing data, and selective data from the Berkeley particle experiment also on board the subsatellites. These data were recorded during several periods of time between 1969 and 1975.

The data descriptions written by the original instrument teams are vital to properly decoding the source data. Also essential is the knowledge about the computer environment during the Apollo era and the history of data archiving since then. Both LSM and SBM data were originally written on computers with 6-bit bytes (that is compatible with the 36-bit word format). At a later time each 6-bit byte was padded with two extra bits of zero so that the data could reside in an 8-bit byte frame. Another source of complications comes from the fact that the data format was machine dependent during the Apollo era. LSM data (mostly written by IBM 7090/7094) has a different definition of alphanumeric characters, integers, and floating point numbers than that for SBM data (written by Unisys UNIVAC), and both definitions are obsolete in today's computing environment.

The Restored Data: We have successfully restored all the SBM data and samples of the LSM data archived at NSSDC. In the LSM data, time words do not appear at fixed or expected locations in data files as suggested in data descriptions. As a consequence processing LSM data requires human inspection of time words and thus is performed only for selected intervals.

Figure 1 shows several examples of the restored SBM and LSM data. The intervals presented are those during conjunction events of Apollo 15 SBM and LSM in different space environments. The triaxial LSM data are expressed in SBM spacecraft coordinates to aid the comparison. As the ephemeris data for the Apollo 15 subsatellite are not available, we use the Apollo 15 subsatellite orbit plots on paper and the position of the Moon to estimate the subsatellite position and orientation. Therefore coordinate transformation is performed in an approximate manner.

In all the examples in Figure 1 the observations by LSM and SBM show very similar magnetic field values. The LSM data present faster fluctuations because of their higher time resolution (at 0.3 s). Compared to SBM observations, the magnetic field magnitude seen at LSM was slightly higher when the ALSEP station was on the sunward side of the lunar surface.

The Missing Pieces: The major missing piece of Apollo magnetic field data is the ephemeris data of subsatellites, which are unavailable in other data sets at NSSDC. We have secured the paper orbit plots for the Apollo 15 subsatellite, but similar plots for Apollo 16 have not been found. Another hurdle for data restoration is the irregular pattern of time words present in the LSM data, preventing us from processing the data in an efficient fashion.

Plan for Further Data Restoration: These missing pieces of Apollo magnetic field data can possibly be recovered by our continuing efforts in data restoration. Dr. Palmer Dyal, the PI of the Apollo LSM experiments, provided to us more than 300 pages of notes for the data sets he submitted to the Federal Records Center (FRC) in the 1970s and 1980s. Among these FRC archives are over 100 boxes of magnetic tapes, documents, and microfiche that are related to Apollo magnetic field measurements. We have contacted the manager of the FRC archive and are actively taking steps to recover these Apollo data sets that have not been available for over 20 years.

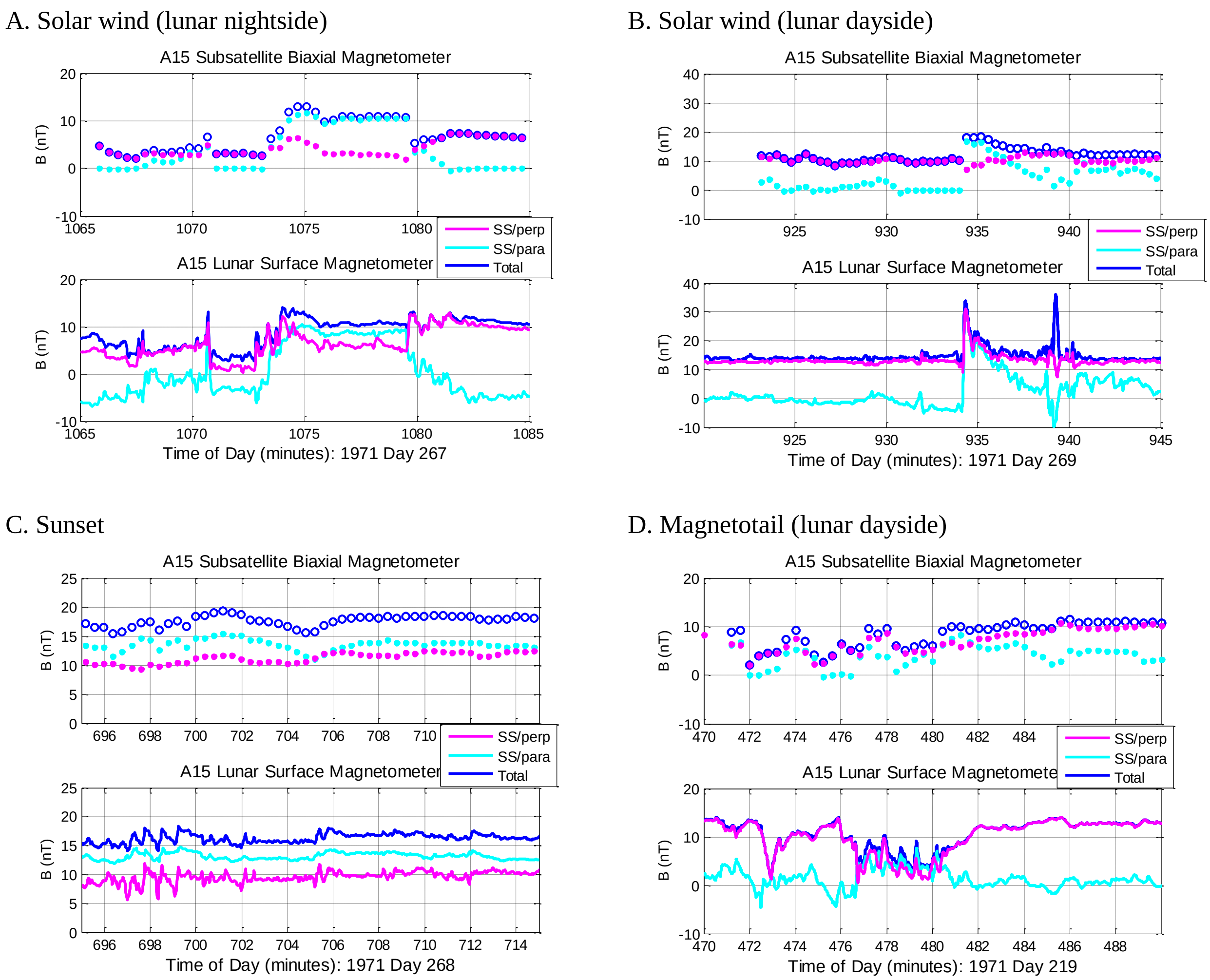

Figure 1. Examples of the restored Apollo Lunar Surface Magnetometer (LSM) and Subsatellite Biaxial Magnetometer (SBM) data in several different space environments. The triaxial LSM data are expressed in SBM spacecraft coordinates for comparison.