DISCUSSION

C. B. Pettersson[1] (written discussion)—The following comments and questions are addressed to the author:

1. An area of specific interest for us is automation of the interface between remote sensing data and computer-assisted design. Such automation would be achieved by digitizing the interpretation and use of the remote sensing data and would apply to terrain analyses for hydrological and route-selection studies as well as to the processing of monitoring data. Related applications would include vegetation and land-use studies. I would appreciate comments from the author regarding the present state of the art in the use of digitized data and future developments in this area.

2. In using digitized data for computerized evaluations and processing, to what extent should regular hard-copy prints be used for comparative study?

3. I would like the author to summarize his views regarding the areas of remote sensing in which standardization or guideline development, or both, would be desirable or possible now or at a future date. In answering this question please keep in mind the areas within the International Association of Hydrological Sciences (IAHS) that are of interest to ASTM.

4. ASTM Subcommittee D18.01 on Surface and Subsurface Reconnaissance, a subcommittee of ASTM Committee D-18 on Soil and Rock, has a direct interest in the application of remote sensing techniques. One subject related to the subcommittee's work is the ground checking of remote sensing data interpretations. Would the author describe the requirements and procedures for ground checking within his area of application?

5. It appears difficult at the present to define the quality of remote sensing data to a general user. The quality scales given, for example, to Landsat imagery are well known. The question remains, however, of what further developments are envisioned within the remote sensing industry that will lead to definitions of quality criteria unique to the various sensing methods and enhancement/interpretation techniques. The bottom line is this: how can a general user purchasing remote sensing data and services ensure in advance that he will get what he wants?

6. Will the author please discuss the selection criteria for remote sensing data to be used for geotechnical engineering purposes—for example, sensor reception frequency, scales, and resolutions. Furthermore, which different types of imagery should typically be used together to best bring out the appropriate contrasts for evaluating soil and rock conditions?

B. F. Molnia (author's closure)—The author's responses to the discussion questions and comments are the following:

1. Digital remote sensing data, be it data digitized from interpretations or data originally collected in a digital format are very commonly used by the geological community. These data serve as a major data layer, to which other levels of data are registered, in many Geographic Information System (GIS) projects. Of the three types of data discussed in my presentation, both types of radar data are collected in a digital mode, while many users commonly digitize NHAP photographs to register them with other remotely sensed types of data or to manipulate their contrast.

2. In my work, I find that is crucial to have hard-copy prints to visualize what the digital data represent and to look at in order to key-in on specific areas that then can be digitally manipu-

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lated. Without the hard copy, it is almost impossible to sit around the table with coinvestigators or clients and have a discussion.

3. Agencies of the United States Government are probably the single largest collectors and users of remotely sensed data. Until the advent of the NHAP program, there was no standardization of method for either data collection or processing. What we need are similar multiagency cooperative arrangements for other widely used and widely collected types of remotely sensed data. With publicly available, inexpensive, "global" data bases, all similar in their acquisition characteristics, the geotechnical community will find much useful information to build upon.

4. Ground checking of data is critical for confirming interpretations made from digital data and hard copies of remotely sensed data. As an example, if one does not field check soils and rocks, it is very, very easy to misidentify materials based solely on their spectral and reflective characteristics.

5. The "general user" is unfortunately in a very difficult position. There are so many types of remotely sensed data available, each demanding training in interpretation, and each with a complicated nomenclature and unique set of characteristics, that without assistance from a remote sensing professional, the user is very likely not to get what he needs. One way to prevent this is to define clearly the questions that need to be answered. Then, the user should seek the advice of a qualified remote sensing specialist. I would suggest that more than one be consulted, and their opinions be carefully weighed, before any contracts are signed. In the United States, many federal and state agencies that archive remote sensing data offer technical assistance to users in data selection.

6. I prefer not to make a blanket statement about selection criteria. Rather, I would suggest that the geotechnical engineer must clearly define the problem that he is trying to solve, formulate the questions that need to be answered, and only then select the data collection criteria that are necessary to solve this problem. In many cases the requirements will be the same, but frequently, the engineer will find that the level of information that he needs to answer questions at one site will be different at another.

"For evaluating soil and rock conditions" is much too general a request. One must again clearly define which specific parameters are of interest. For almost any situation some combination of aerial photography with its very high resolution, satellite data with its spectral reliability, and radar with its texture determination capabilities can be used to solve a specific problem. All of these data types must also be coupled with careful ground truth.