Radio Description of Geologic Features:

Examples and Conclusions

by

Ivo Lucchitta, John W. M'Gonigle
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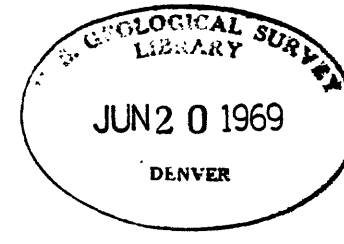

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Introduction

This report presents three examples of radio description of geologic features. The descriptions and their annotations reflect ideas derived from a field test held in the Rainbow Gardens area, near Las Vegas, Nev., in April 1967. The test employed a data-reduction center conceptually similar to that proposed for lunar exploration. The purpose of the test was to study certain aspects of geologic exploration--description, communication, and recording--as adapted for use with the data center. In the test, a field man (corresponding to the astronaut) radioed geologic descriptions to the data center, where a "communicator" edited them for clarity and completeness, while "recorders" systematically recorded descriptive data and compiled maps and sections.

A basic function of a data center is to analyze incoming geologic data, so as to be able to redirect a continuing geologic traverse to ensure gathering the greatest possible amount of significant information in the time available. If the center is to function efficiently, the data team must be able to promptly assimilate the incoming field data, record them unambiguously, and literally visualize the field relations; otherwise, they cannot really contribute to the field man's efforts. The need for immediate intelligibility of the field data implies a need for systematic description procedures. The discussion of such procedures in the test report** is documented and illustrated by the descriptions in this paper.

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**Lucchitta, Ivo, M'Gonigle, J. W., Schleicher, David, and Hait, M. H., 1969, Use of a data center in geologic mapping: A test report, in Geologi- Survey research, 1969: U.S. Geol. Survey Prof. Paper 650-C [in press].

Transcript

Part A of this paper presents a description taken from the test and a revised, improved description covering the same ground in about the same detail. Both descriptions have explanatory annotations. The field transcript has been "edited" as well, in order to emphasize its ambiguities; many of these are admittedly minor, but they are the very things that make the final assembly of a geologic report so difficult. The editing is by no means complete, and the improved version is by no means perfect; both are merely illustrative. "C," "R," and "F" refer to communicator, recorder, and field man, respectively. The field man in this test is an experienced and articulate field geologist. Obviously, it is relatively easy to edit and improve the transcript of a rough field description. The point is that the subject matter of this description is really so routine and so straightforward that a methodical approach and a little practice in systematic description would have largely eliminated the need for editing.

Part B presents an example of what we would consider a "good" description. Though based on the test, it is fictitious, the better to illustrate several points to be made. No responses from the data center are given, since the example focuses on description, rather than on the interplay between field man and data center.

Perhaps the best way to understand the importance of a systematic approach to geologic description is to assume the role of recorder, that is, actually to sketch sections or diagrams from the information given in the descriptions.

Summary and Conclusions

If geologic descriptions are to be radioed to a data center, they should be immediately intelligible; to be intelligible, they must be presented systematically. A description guide has proved to be one means for doing this successfully. The following conclusions were drawn from the field test and were employed in constructing the "improved" and fictitious descriptions.

1) A description guide is a valuable mnemonic aid. Because any such guide is deliberately concise--hence not comprehensive--practice is required for its proficient use.

2) Description should be systematic and should, in general, proceed from the system to the component, the general to the particular, the rule to the exception, the far to the near. This is necessary not only to ensure the satisfactory communication of information, but to encourage the completeness and accuracy of the observation itself, in some cases bringing out details and relations otherwise unseen. Descriptions probably need not be rigidly systematized; certainly, though, an organized presentation aids recording. Because such a procedure is logical, it is relatively easy to learn and use.

3) In general, information should not be given between stops on a traverse because it is confusing and almost impossible to record systematically.

4) For each description, it is important to establish the geologic context against which information can be seen, understood, and

evaluated. Accordingly, the field man should first present a generalized picture, indicating what information he will give and, in some cases, why. In general, geologic objectives should be planned before the traverses, and the data center should remind the field man of them at each stopping point.

5) The field man should categorize or label information before giving it; he should, for example, indicate whether the information should go on a map or on a recording form, or whether it is an incidental note to appear only on magnetic tape. He should also indicate how detailed his description will be, thereby preparing the data team for recording the data in the most appropriate ways. If the field man plans to give information on a particular subject at a later time, he should say so.

6) Verbal description of geometric relations is difficult. Until an electromechanical line tracer or similar device becomes available, such description should be kept to a minimum. Possibly, geometric information should be handled by conventional mapping, or by annotating Polaroid photographs in the field; the function of the data center would then be to compile and coordinate only verbal data.

7) Frequent summarization of data by the data center for the field man enables the entire team to check the data for errors and to keep abreast of the compilations.

8) Whenever possible, the field man should describe objects by comparison with familiar objects or with objects that were described previously.

9) Distinctive, characteristic, and important features of any object should be mentioned even though they may seem "obvious" to the field man.

10) Topographic and photogeologic features should be labeled before the traverses to speed up description.

11) The field man should not waste time verbally describing features that are best portrayed by a photograph, but he should give enough information about each photograph to make its significance clear.

A. ACTUAL DESCRIPTION

Field Transcript

"Editing"	Text	Comments
	F: OK. I am in the middle part--hold on a minute (pause)--in the middle part of Unit four, at the following coordinates: (pause)	Coordinates specify his geographic position; should precede other comments. Description should be thought out before communication.
	C: That was a little bit "staticky." Let me repeat these coordinates as I got them: five point eight, H point three-eight, over.	Unnecessarily wordy.
	F: You're coming in intermittently. Repeat.	
	C: Your coordinates are as follows: five point eight, H point three-eight, rather H three point eight, over.	Notations should have been worked out before test.
	F: Yeah, that is correct. There's a broad wash cutting through light and dark bands at that point.	Confirmation of location, but not very specific; however, may have been clear to geologist with air photos.
	C: Check.	Here and commonly elsewhere F does not indicate that his transmission is over.
	F: You hear me?	

"Editing"	Text	Comments
	C: Yes, go ahead. Can you hear us?	Obvious radio problems, but shouldn't need this much discussion.
	F: You keep getting cut out.	
	C: How do you read me now?	
Is "this" point the same as "that" point, above?	F: OK. (Pause) At this point I am on the west edge of a dark strip that runs across, over.	Relation of this to previous description not specified, hence not entirely clear. "Strip" - "band" ambiguity may well not have existed for geologist with air photos.
as terminated by the broad wash?	C: Roger. (? ≅ band ambiguous)	
	F: The section below this point is the same as that described earlier, the reddish brown gypsum and shale.	
when?		Data center should check to make sure they agree with F on which shale and when.
Not clear which unit this is		
	C: Do you want any of that former description reread to you? Over.	
	F: ...beds--ah--make up this bundle. I'll start at the bottom and describe these going up-section.	Information lost by poor radio procedure; not subsequently recovered.
of what?		F should indicate how detailed his description is going to be.
Antecedent not entirely clear.		
	C: Give us the point again where you are going to start. Are you going to start from your coordinates?	"Editing" by data center to clarify ambiguity--but then this ambiguity really shouldn't exist.
	F: That's correct.	

"Editing"	Text	Comments
relation to old part? (apparently higher)	C: Do you want anything--any of the previous descriptions read to you? Over.	
	F: No. I'm starting on a new part of the section. Over.	
	C: OK. Go ahead.	
How sure are you? "positive"? "reasonably sure"?	F: I don't know how much new section was below me, but it all looks the same as what I had been through before--those reddish brown gyp shales.	
Are you saying, then, that there isn't any "new" section that you haven't described?	C: OK.	
How is the "bed" related to the "band"?	F: At this point, the west edge of that dark band, there is a two-foot bed of siltstone.	
	C: Go ahead.	
	F: Fresh color: pale yellowish brown; weathered: light brown and moderate brown.	
	C: Just a minute. Are you going to be giving us a more or less generalized description of these stratigraphic units?	Amount of detail should have been specified earlier.
A conventional stratigraphic term would have been more definite and less liable to be misunderstood over the radio.	F: I'm going to break it down into four or five major little bundles. (it ← antecedent?)	This and the following statement give the context for the description that is to follow.

"Editing"	Text	Comments
	C: OK.	
stratigraphic sequence? unit?	F: And the whole thing is only forty or fifty feet thick.	More precise term would eliminate ambiguity.
	C: OK.	
Are both the quartz(?) and gypsum very fine sand? Or is there very fine sand of indeterminate composition in addition to quartz and gypsum grains of indeterminate size? What are the proportions of these components?	F: Distinctive(?) siltstone that I just mentioned is very thin bedded; small-scale cross bedding (how thin? how small?) and ripple marks; contains very fine sand, quartz(?) sand and gypsum grains.	Words followed by "(?)" were not unambiguously recoverable from magnetic tape; any such ambiguity should be clarified immediately.
	C: OK.	
	F: Then there's the next unit is (sic) the reddish brown gypsiferous shale.	Illustrates possible ambiguity in verbatim transcript; systematic presentation and record-keeping largely eliminate this confusion.
	C: How thick?	
	F: Ten feet.	
	F: Very soft and crumbly and does not stand up as a ridge at all.	No acknowledgement from C.
	C: Roger.	
similar lithology? section repeated by faulting?	F: It's the same as the same part of the unit below. Over.	
	C: OK.	

"Editing"	Text	Comments
a stratum — or a unit?	F: The next distinctive bed is a fine-grained sand- and siltstone.	Note that hyphen after "sand-" is a post-facto interpretation.
	C: Check.	
	F: Its fresh color: light gray; weathers olive gray to olive black.	
How thin? How small? Range? Average?	C: Check. How thick?	Prompting should not come here in the middle of F's thought process; later if necessary.
	F: It's about two feet thick. Thin bedded to papery, small-scale cross bedding. (Pause) It is overlain by medium-grained sandstone four feet thick; fresh and weathered colors the same--pale orange to yellowish gray.	"Loose" terminology ok if F and data center have agreed on common definition.
	C: OK.	
	F: Hold on a minute. That last sandstone that I just described to you--the light-colored, medium-grained sand--should be given as a special unit within a main bundle of rocks that consist of two principal types of which that is one.	Data center might well not automatically associate "light-colored" with the colors given above.
	C: Hold on. (Pause) Could you go over that last discussion again?	Less ambiguous when written than when spoken, but certainly confusing.

"Editing"	Text	Comments
much better than previous presentation	F: Yeah. That last light-colored, medium-grained sandstone bed is just one unit in a bundle that consist of alternating beds of that type and another type.	The improvement in this description over the previous one indicates how little preparatory thinking is necessary to make a fairly good description.
	C: OK. How thick is the bundle?	Premature prompting.
	F: The bundle is about thirty feet thick.	
	C: Roger.	
	F: And it makes a weakly resistant ridge that stands up higher than the gypsum beds on both sides.	Sandstone is weakly resistant and yet "very crumbly" (third description below). F should explain such apparent contradictions.
	C: Roger.	
	F: It consists of that medium-grained sandstone interbedded with siltstone. The siltstone has the following colors: fresh color--yellowish gray and very light gray; weathers olive gray and brownish gray.	
	C: Weathers olive gray and brownish gray? Over.	(Clarification because of poor transmission.)
ambiguous	F: That's right. That is a very thin-bedded unit--papery beds and sheets in beds two feet thick.	
	C: Roger.	

"Editing"	Text	Comments
	F: Interbedded with that: medium sandstone that is very crumbly, and it's in beds two to four feet thick.	Note the importance of punctuation for clarity.
	C: Roger.	
Do you really mean more than just "lenses"?	F: Some of the beds are discontinuous, flat lenses.	
	C: Some of the sandstone or siltstone beds, or some of each?	An example of worth-while "editing". But a systematic description procedure would have eliminated the ambiguity.
	F: _____ They are locally contorted moderately.	Information not recoverable from tape. Note that "they" thus has no antecedent.
	C: OK.	
a new subunit?	F: And that bundle is overlain by about ten feet of the reddish brown gyp shale.	
	C: OK.	
Good Lord! "bundle"?	F: And then the last distinctive unit in this whole(?) stack is about--just a minute (Pause)--consists of two very coarse-grained beds, each about four feet thick separated--hold on a minute.	Unprecedented usage of "stack" leads to confusion, particularly in this description of a fairly complex stratigraphic sequence. No understanding is possible unless "units" are carefully distinguished from "subunits" and so on.
	Background voices: A: What unit was this now?	
	B: This is the last unit in	

"Editing"	Text	Comments
	this little bundle.	
	C: Which bundle? I thought he said it was overlain by sand and siltstone...	
In what sense? Are these the same as the 4-foot beds above?	F: I'll give you different dimensions. There are two main beds, each about twelve feet thick, separated by a poorly exposed gyp shale unit.	
	C: How thick's the gyp shale?	
	F: Ten feet.	
	C: Got some questions.	
	R: Hear me?	
	F: OK.	
	R: OK. You have a thirty-foot thick bundle of alternating sandstone and siltstone, and the way I have it, over that you've got ten feet of red brown gypsiferous shale as described previously, and above that apparently there is the two coarse-grained beds which are separated by a gyp shale unit. Is that right?	A summary from the data center, a valuable check for both data center and field man, especially in the case of a complicated description.

"Editing"	Text	Comments
	F: Right.	
	R: OK. Are you going to describe these coarse-grained beds a bit?	
	F: _____. Medium to coarse-grained sandstone, thin-bedded--just a minute-- (Pause) They consist of quartz grains, subround to round. There are locally granule beds. Fresh and weathered color about the same, ranging from yellowish gray to pale yellowish orange.	Another lost transmission.
	C: OK.	
	F: This rock is very crumbly and makes subdued, rounded ridges.	
	C: OK. Does your previous description apply to both of these twelve-foot beds? Over.	
	F: ~~These~~.....some chert and some rock fragments.	Interruption bespeaks poor radio procedure. Practice largely eliminates this problem.
	C: I'm sorry, we cut out part of your last description.	
	F: Composed mostly of quartz, but some chert and a few rock fragments.	

C: OK. Now this description applies to both of these twelve-foot units?

F: That's right. Other mineral grains observed were sparse(?): the two(?) feldspars, a few pieces of dolomite and quartzite.

little variety, few grains?
little variety, many grains?
wide variety, few grains?

Two key words are questionable on

C: OK.

F: And that's overlain by more of the reddish brown and locally tan and gray gypsum shales.

What's the antecedent?

C: OK, this bundle of silts and sands that you have been giving us--do these rocks make up that prominent ridge that we can see on our aerial photographs--the ridge that is dark to the west and light to the east?

F: That's right. That third sand and granule conglomerate that I just described is the light strip that's on the east.

It's hard to believe that the "silts and sands" must be the same as the "sand and granule conglomerate!

unprecedented usage — the medium to coarse sandstone beds?

C: Roger.

F: That was a pretty crummy description, wasn't it?

Improved Transcript

Activities		Text	Comments
Gives geographic position	F:	I have the following coordinates: (garbled transmission)	
	C:	I have coordinates five point, Hotel point three-eight. Correct?	
Specifies marginal communications	F:	You're coming in intermittently. Say again.	
	C:	Your coordinates: five point eight, Hotel point three-eight. Over.	
Confirms ~~of~~ coordinates	F:	Roger. I'm on the east side of the broad wash that cuts across those alternating light and dark beds on the photos. I'm at the west edge of the southernmost dark bed. Over.	
Keys discussion to photo-geologic planning done before traverse.	C:	Roger.	
	F:	You hear me?	
	C:	Yes, go ahead.	
Gives stratigraphic position.	F:	I'm in the middle part of Photo-unit four, at the top of what I'm reasonably sure is the reddish-brown gypsum and shale unit I described yesterday afternoon. Check?	"Check" suggests the end of a "quantum" of data.
C offers reference to data center's records at what he deems an appropriate time.	C:	Roger. You're at the top of Unit four-Charlie. Do you want any descriptions of the lower units read to you? Over.	"Over" indicates end of one complete subject before presenting another.
	F:	No. I'll start at my coordinates, at the base of Unit four-Bravo, and describe that going up section. Over.	
	C:	Roger, go ahead.	

Indicates his plan for describing Unit 4-Bravo.	F:	Unit four-Bravo is four-zero or five-zero feet thick; I'll break it down into four or five subunits and describe them separately and in detail. Over.	Use of "four-zero"(as opposed to "forty") is good radio practice to avoid misunderstanding.
	C:	Roger.	
Describes Subunit I	F:	The lowest subunit is a two-foot bed of siltstone. Fresh color--pale yellowish brown, weathered color--between light brown and moderate brown. Check?	
	C:	Check.	
	F:	The siltstone is thin-bedded, beds typically two to three centimeters thick; it has ripple marks, and crossbedding that typically transects three or four of the thin beds. The siltstone contains about one-five percent very fine sand--half of that quartz and half gypsum. Over.	
	C:	Roger.	
Describes Subunit II	F:	The next subunit is a ten-foot bed of reddish brown gypsiferous shale. Check?	
	C:	Check.	
	F:	Very poorly coherent; tends to weather into a shallow trough. Its general appearance is like that of the red gypsiferous siltstones lower in the section. Over.	Description by comparison
	C:	That would be the siltstones of Unit four-Charlie?	
Describes Subunit III	F:	Affirmative. The next distinctive subunit is a two-foot bed of fine-grained sandstone and siltstone. Check?	
	C:	Check.	
	F:	Fresh color--light gray; weathering color between olive gray and olive black. Check?	
	C:	Check.	
	F:	Bedding two centimeters to paper-thin, typically one or two millimeters. Occasional cross-bedding that typically involves a few individual beds. Over.	

Activities	Text	Comments
	C: Roger. Could you comment on the proportion of fine-grained sandstone in this subunit?	"Editing" by data center to ensure greater completeness.
	F: Roger. About three-five percent.	
	C: Roger. Thank you.	
Describes Subunit IV	F: The next subunit is a medium-grained sandstone, four feet thick. Check?	
	C: Roger. Check.	
	F: For the sandstone--fresh and weathered colors the same--between pale orange and yellowish gray. Check?	
	C: Check.	
	F: Correction on that description--check?	Orderly way of correcting previous (incorrect) definition of Subunit IV.
	C: Roger, go ahead.	
Describes Subunit IV (correction)	F: The next subunit, going up section, is a three-zero-foot-thick series of two alternating rock types holding up a weakly resistant ridge that stands slightly above the non-resistant gypsum beds on either side. Check?	
	C: Check.	
	F: The two rock types occur in roughly equal amounts; they are the medium-grained sandstone that I just described, and interbedded siltstones. I'll finish describing the sandstone. Check?	
	C: Check.	
Describes Subunit IVa	F: The sandstone is very poorly coherent even though it makes a low ridge. It occurs in beds that are typically two to four feet thick, and that tend to be thin lenses. These lenses typically extend for about three-zero feet along strike: the beds within them are locally contorted. The lenses very probably represent stream channels and the deformation is probably due to slumping.	F feels that these interpretations need no further documentation. He would probably take photographs.

Activities		Text	Comments
	C:	Roger.	
Describes Subunit IVb	F:	The interbedded siltstone has fresh color between yellowish gray and very light gray weathering color olive gray and brownish gray. Check?	
C checks poor transmission.	C:	Weathers olive gray and brownish gray? Over.	
	F:	Roger. It has papery sheets and laminae a few millimeters thick in beds typically two feet thick. Over.	
	C:	Roger.	
Describes Subunit V	F:	This subunit is overlain by a new subunit that I'm distinguishing on the basis of color; this new subunit has four members. Check?	
	C:	Check.	
Describes Member 1	F:	The lowest member is a ten-foot bed of reddish brown gypsiferous shale; next is a one-two-foot bed of medium- to coarse-grained sandstone. Check?	"Ten" is unambiguous; "twelve" is liable to be misunderstood, hence "one-two."
Describes Member 2	C:	Check.	Giving general characteristics of members establishes "setting."
Describes Member 3	F:	The next member is another ten-foot bed of red gyp shale, and finally, another one-two foot bed of sandstone like the previous one. Check?	
Describes Member 4	C:	Check.	
	F:	I'll describe these two rock types now in more detail. First the gyp shales, check?	
	C:	Check.	
Describes Members 1 and 3	F:	The shales are generally reddish brown, but locally tan and gray. Apart from their colors, they're apparently the same as the red gyp shales in Unit four. Over.	
	C:	Roger.	

Activities	Text	Comments
Describes Members 2 and 4	F: The sandstone beds are very poorly coherent, but resistant enough to make subdued, rounded ridges. Check?	
	C: Check.	
	F: Fresh and weathered color about the same--ranging from yellowish gray to pale yellowish orange. The gray colors are predominant in the lower part of the section. Check?	
	C: Check.	
	F: Dominant grain size is medium to coarse sand; occasional granule beds four or five centimeters thick make up about ten percent of the rock. Check?	
	C: Check.	
	F: Grains are subrounded to rounded, very dominantly quartz, with a few percent feldspar grains--both orthoclase and plagioclase--and scattered grains of dolomite and quartzite. Over.	
	C: Roger. Two questions: first--this subunit differs from the previous subunit in that its finer-grained beds are red-brown gyp shale rather than yellowish siltstones and its sandstones are medium to coarse with granule beds rather than strictly medium-grained. Check?	Summary statement from data center to confirm complex description.
	F: Check.	
Relates stratigraphy to geomorphology.	C: Roger. Last question: do these interbedded sandstones and siltstones make up a ridge on our photos--the ridge that is dark on the west and light on the east?	"Last" reminds F that there are no further questions
	F: Affirmative. The third member--the upper coarse sandstone--is the light strip on the east. Over.	
	C: Roger.	
	F: That was a pretty good description, wasn't it?	

HYPOTHETICAL "GOOD" DESCRIPTION

Activities	Text	Comments
Checks with data center.	DF ready?	
Gives geographic and photo-geologic location.	I'm at Station one-six, coordinates Echo point eight, four point four (in Photo unit six).	"Housekeeping" information for the station.
Specifies number and type of descriptions to be given from station.	I have a good view of the surrounding country, and I will give you four remote descriptions Check?	Phrase "good view" suggests reliability of data. Specifying the number and type of descriptions to be given prepares data center.
	Remote Description one, of faults Foxtrot and Foxtrot one.	Housekeeping information for first description.
	General location of target: Bravo point seven, two point eight.	General location adequate for data center to find previously defined feature on photographs.
	Photograph: One-six dash one, bearing two-two-zero, general view of fault area from this station.	Phrase "general view" suggests amoung of detail and reliability of description.
	Check?	
Specifies location of new fault and keys it to photomap.	In this area, fault Foxtrot is correct as mapped, and I will say no more about it. There is another fault, however, that has not been mapped and that is parallel to, and about one-zero-zero feet to the south of, the first one. It is visible on the photo as an indistinct dark line. I will call it Foxtrot One.	Minor application of problem solving method.

Activities	Text	Comments
Gives criteria by which fault can be recognized.	Check? The fault plane itself has no topographic expression, but the trace of the fault is defined by different color on opposite sides of the fault and by offset of small gullies and ridges that	"Check" indicates that more information is forthcoming.
Documents his interpretation.	follow strike of rocks. Offset key beds indicate a left-lateral separation of about six-zero feet. Check? Dip of fault plane is poorly expressed, but probably subvertical. I cannot trace the fault toward me, owing to poor exposure--it may or may not continue through the vicinity of this station.	Data center may be able to see this on photo--once they know where to look.
	Over.	"Over" indicates end of transmission and encourages questions.
	Remote Description two, unconformity between Photo unit six, below, and Photo unit seven, above.	Housekeeping information for second description.
	Location of target: to the south of station, general area of Echo point four, one point six.	Generalized location quite adequate in this case: serves mainly to orient people in data center.
	No Photographs.	
	Check?	
Ties stratigraphy to geomorphic characteristics.	Basal conglomerate of Unit seven forms massive cliff at the top of ridge. Dip about four-five east, strike roughly north. Scattered exposures of Unit six on slope below cliff show that Unit six is beveled by the conglomerate of Unit seven in such a way that progressively younger beds are truncated to the north. In other words, Unit six has a more westerly strike than does Unit seven.	This complicated description shows how difficult it is to convey "geometric" data in words.
Gives clarification of difficult concept.	Check? From here, the apparent angle between beds of Unit six and Unit seven is about zero-four degrees, opening to the north. To get a more precise figure, you can note that the resistant beds on which I am standing are truncated by Unit	This allows data center to improve on observed value by means of calculated value.

Activities	Text	Comments
Keys his observations to photomap.	seven at coordinates Echo point three-eight, one point eight. You can see that on the photo. Check? From here, the unconformity seems rather smooth on a large scale, being characterized by swells and swales commonly several hundred feet in wavelength, and with amplitude of only a few feet or tens of feet. There seems to be no conspicuous coarsening of the conglomerate in the swales. Over.	Field man obviously looked for something he expected, without finding it. Possibly a very important observation.
	Remote Description three, of fault Foxtrot. Location of target: Golf point one, four point eight-five, to the northeast of station.	Housekeeping information for third description.
	Photographs: One-six dash two, one-six dash three, bearing zero-six-five.	
	Check?	
Relates geology of target to geology of station.	I'm looking at the northeastward continuation of fault Foxtrot, on which I am standing. The fault is correct as mapped, but I can fill in some details. Check? The strike of the fault between present station and target is zero-six-five. At target, where the fault is well exposed in the gently sloping side of the valley, dip of the fault is six-eight degrees to the south. Check? From here it looks as though the red beds of Unit eight, north of the fault, are juxtaposed against the basal conglomerate of Unit seven on the south. The fault is actually a fault zone generally similar to that described for fault Charlie a few stations ago, but differing in that the width of the fault zone seems to vary along strike, ranging from about five feet to about five-zero feet, and typically being about one-five feet. Check? Within a zone	Field data confirming and augmenting photogeologic data.
Establishes setting and specifies reliability of his observations.		
Amends photomap. Describes by comparison and contrast.		Field man neither gives, nor should be expected to give, exact station number. Both range and average value of measurement are given.

	about one-five-zero feet wide and centered on fault Foxtrot, there are several subsidiary faults that are subparallel to Foxtrot and show left-lateral separation of ten feet at most. I can also see some drag of which I	
Applies problem solving method.	have sufficient three-dimensional exposure to make me think the idea of oblique slip--was that hypothesis "b"?--is the correct one for this area. More on this later, after I've traced the fault to the northeast. Over.	No unnecessary documentation given here. Data center should know which hypothesis is dicussed. This statement should prevent the asking of untimely questions.
	Remote Description four, stratigraphic section exposed to the south of station.	Housekeeping information for fourth description.
	Location of target: vicinity of Echo point six, three point one.	
	Photographs: One-six dash four, bearing one-eight-five.	"one-eight-five" has three syllables, "one hundred eighty five" has six. Even though the former may look ponderous in writing, it is quicker to say, and certainly less easy to misinterpret over the radio.
	Check?	
Defines what is going to be described.	I am going to describe a stratigraphic section of Photo-unit six below the angular unconformity at the base of Unit seven and above the basal, resistant, member of Unit six. Check? The	Section is treated as a "system", and properties of this system are briefly described.
Gives geomorphic characteristics.	section in question is geomorphically weak and forms a strike valley down which I can look. The bottom of the section coincides with the lowest part of the valley. Strata dip east	
Gives attitude. Gives information on exposure.	about four-five degrees. Exposures are moderate to good, and in the form of an oblique cross section. Check? The section is about two-five-zero	Information on quality and form of exposure suggests reliability of data that follow.

	feet thick and apparently conformable; it can be broken down into three members, distinguished by color, geomorphic resistance, and texture-composition. The lowest member, about one-three-five feet thick, is generally light greenish gray in weathering color, relatively weak in resistance to erosion, and probably composed largely of fine-grained sandstone or siltstone, locally interbedded with carbonates and possibly with gypsum. Check? The middle member, about three-zero feet thick, is medium to dark brown, relatively resistant to erosion, and probably composed largely of sandstone. Check? The upper member, about eight-five feet thick, is brick red, relatively weak, and composed mostly of fine-grained detrital material, probably siltstone. Check? From here I can see no evidence of disconformity between the various members. The beds appear consistent in attitude and undisturbed by faults or folds. I will now give more detailed descriptions of the three members, starting from the lowest. Check?	Mentioning the conformable relationship at this point helps the data center in constructing sketch sections. The three members are treated here as "components" of the section being described ("system") and are described in detail sufficient only to define them. Sequence followed is: dimensions, color, weathering characteristics, composition texture, structure. Information on texture-composition given in a remote description is tentative, of course. Nevertheless, a field man experienced in the weathering characteristics of various rock types in the climate of the area studied can be remarkably successful in identifying from a distance the gross texture-composition of a rock. Important for data center to know that field man has considered the possibility of discontinuities in the section before describing it. This prepares the data center for the "more detailed" description that is to follow. The preceding general description allowed the data center to make outline sketches, to be filled in by the more detailed data.
Gives general description of lowest member.		
Gives general description of middle member.		
Gives general description of upper member.		
Gives information on structure.		
Introduces detailed description of the three members.		
Gives detailed description of lower member.	The lowest member is exposed moderately to well, in oblique cross section. The overall weathering color is light greenish gray, five Golf Yankee eight slash one, the color becoming lighter from the bottom to the top of the member. The member is generally poorly resistant to erosion and forms a slope, but the lower	Lower member is not treated as "system". Exposure, color. Weathering characteristics.

Defines components of lower member.	one-third or so is somewhat more resistant and forms a ledgy slope. Check? Three interbedded lithologies can be recognized: 1) first, medium to light greenish gray, very fine-grained sandstone or siltstone, about seven-zero percent of member; 2) second, medium gray to white, banded poorly resistant rock, probably gypsum, about ten percent; 3) third, medium gray, bedded carbonate, about two-zero percent. As mentioned earlier, the lithologies are interbedded, but the carbonate, which forms up to about four-zero percent of the lower third of the member, decreases to zero higher up. Check? The siltstone and gypsum appear to have indistinct bedding; the carbonate occurs in beds one-half to one and one-half inches thick. No primary or secondary structures are visible from here. Both upper and lower contacts appear conformable. Check? The middle member is well exposed in cliffy cross section. It is moderate brown, five Yankee Romeo four slash four, to moderate yellowish brown, ten Yankee Romeo five slash four, in weathering color, and thus is easily distinguished from other members of this section. Check? Weathering resistance is greater than that of the other two members.	Composition. Lithologies treated as "components". Distribution of lithologies. Structure Middle member treated as "system". Exposure, color. Distinguishing characteristics.
Defines components of middle member. (here only one component)	1) Only one lithology is present, namely, sandstone, probably rather coarse grained, of various shades of brown. Locally, however, there are thin and irregularly distributed lenses of finer-grained, reddish brown material, probably siltstone. Other lenses are probably composed of coarse sandstone and contain pebbles as much as two inches in diameter. From here I cannot give a reliable estimate of the average pebble size. Check? Bedding is irregular, festoon cross bedding common. I think I can see graded bedding	Composition. Lithologies treated as "components." Does not give distribution of lenses, as this would be inappropriate at this level of observation and could easily be documented in a photograph. Does not give information that would be unreliable and possibly misleading.

in some of the coarser-grained units. From this vantage point, I see no evidence of channeling at the base of the member, even though I would expect some, as I think the member is a stream-laid deposit. Check?

Field man clues data center on his thinking. He considers this member fluviatile, and therefore he has searched for the channeling that one would expect at the base of such a deposit. Statement of hypothesis and attempted verification thereof.

Gives detailed description of upper member.

The upper member is moderately exposed in oblique cross section. The weathering color is moderate reddish brown, ten Romeo four slash six, irregularly veined with grayish pink, five Romeo eight slash two. Check? Weathering resistance is low; the member forms a gentle slope cut by gullies which give good exposures. Only one lithology is exposed, namely a very fine-grained detrital material, probably siltstone, which, however, is laced with the irregular veins mentioned earlier. These veins have various orientations and may represent discoloration along fractures, or veins of a secondary mineral, possibly selenite. Check? Bedding is indistinct or massive. No joints can be seen from here. The upper contact, with the basal conglomerate of Unit seven, is distinctly irregular on a large scale, inasmuch as I can see swells and swales several hundreds of feet in wavelength and several feet to several tens of feet high. In detail, however, the contact appears smooth. Over.

Upper member treated as "system".

Exposure

Color

Weathering resistance.

Defines components of upper member.

1)

Composition-texture. Lithologies treated as "components".

Possible interpretations of certain features.

Structure.

NOTE: As an illustration of one of the advantages of using a data center, consider how long it takes to read--and to transmit--the above amount of information, and then think how long it would take to record all this in a notebook. A notebook recording would almost certainly be less comprehensive and complete.