STEREOSCOPIC GROUND PHOTOGRAPHS IN FIELD GEOLOGY

by

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Summary

Stereoscopy with ground photographs taken in the field is an obvious but apparently little used technique. Using the methods of normal aerial photography, stereo-pairs and line overlaps can be taken. The resulting three dimensional stereomodel greatly assists in the interpretation of geology and, should there be the requirement, photographs can be planned for use with the stereometer, thus making quantative determination a possibility.

Introduction

The value of aerial photographs to field geology is well established, and there can be few field geologists who do not make use of stereoscopy, both in the field and the laboratory. It has always seemed to follow that field geology would make equal use of stereoscopic ground photographs, and it is an invariable surprise to find this aspect largely ignored. The advantages of stereoscopy with ground photographs are just as significant as with aerial photographs and do not depend on special equipment. Indeed the rather expensive stereocamera is completely unnecessary and, using a single camera, distance exaggeration can be any desired amount, giving stereomodels which reveal more detail than can actually be seen when standing at the same viewpoint. Furthermore if a record is kept of such items as baseline measurement between photograph stations, positions of prominent landmarks and camera focal length, information retrieval can be quantitative. Close up stereomodels permit more accurate appraisal of many features ranging from orientation of bedding, joints etc., to details of shell beds or of individual "non collectable" fossils. The minimum value of these stereomodels therefore is to provide a permanent three dimensional check on observations, and the maximum is to add unrealised facts to the observations and to permit some quantative evaluation. Moreover the method is so simple that any individual can achieve impressive results without prior training, and the additional expense is minimal. For convenience, comments below are placed under headings of distant and near outcrops, although in essence there is no major difference in principle.

Distant Landscapes

The advantages and disadvantages of ground stereoscopy of distant landscapes are comparable to those of high oblique aerial photographs. Such ground stereoscopy is of particular value in situations where vertical aerial photographs do not permit reasonable interpretation. The most obvious examples are the vertical cliffs which are so common along the coasts and in mountainous areas, or it may be that the scale of the aerial photography is too small to show required details or that it was not taken at the most suitable time of year (for example north facing slopes on many British air photographs are in deep shadow, and ground photographs can fill in the missing information). Even where the vertical photographs allow a first order interpretation ground stereoscopy can still make a most important contribution, far exceeding that to be derived from single flat photographs. Reference to plate 6 will immediately reveal the additional information available when the stereoscope is used. The methods to be employed in taking the photographs will vary considerably, depending upon the nature of the ground to be photographed and the sort of information retrieval which is required.

Stereopairs are most commonly used. Frequently it is single crags on mountainsides for which the photography is required, or on other occasions it may not be possible to move a sufficient distance parallel to the exposure to take more than two or three stereo-photographs.

Line overlaps will occasionally be appropriate, especially in the case of sea cliffs, when it will be possible to sail at any required distance parallel to the cliffs. Some inland escarpments also lend themselves to this kind of treatment.

In all cases whether steropairs or overlaps are being taken there are a number of general points which are applicable, and these are as follows:-

1. The camera focal length should be recorded.

2. Exact positions of several landmarks in the field of view should be noted on the vertical aerial photographs and maps, and on field sketches.

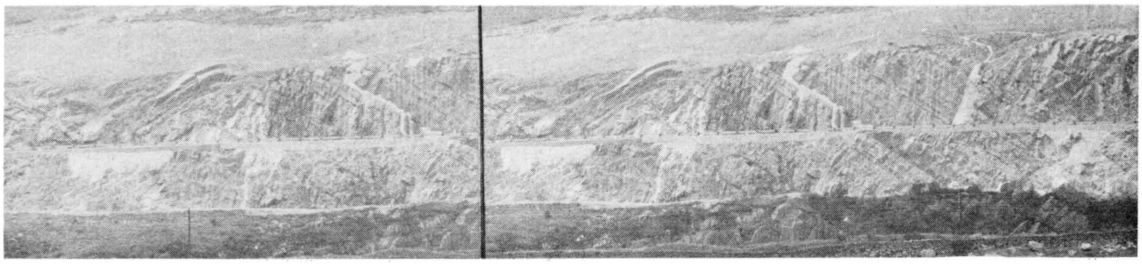
3. The compass orientation of the camera should be recorded and should be the same for each camera position, and the camera elevation or depression should also be the same for each position. In the case of line overlaps it may be necessary to photograph along doglegs, in which case camera orientation would periodically be altered.

4. If quantitative measurements are to be made, for example with the stereometer, base line measurements between stations should be taken and the positions of these stations accurately recorded on the aerial photograph. It will be appreciated that camera spacing between individual photographs depends on a number of factors and the following are relevant.

a) Normally, largely for reasons of economy, aerial photographs are taken with a 60% overlap, resulting in considerable vertical exaggeration. This is generally necessary since the eye cannot resolve stereoscopically at distances much greater than 400 metres and the effective eye base must therefore be appreciably increased.

b) Ground photographs will vary between two extremes. On the one hand cliff faces may present similar "relief" (in relation to a vertical plane) to that presented by topography in the aerial photographs and a similar 60% overlap may be used with advantage. This is especially so in the case of line overlaps, since the greater the overlap the greater the number of photographs which will be required. The new M6 section 1 mile south of Tebay, Westmorland (Plate 6A) required 18 photographs for a line overlap 500 metres long, and 5km. of the coastal cliffs of Akrotiri, Cyprus required 70 photographs. At the other extreme mountainous terrains may present a considerable depth of view and in these cases more than 60% overlap is needed if the whole view is to be readily accommodated stereoscopically. If sequences resembling line overlaps are required for such areas, the effect is best achieved by a series of overlapping stereopairs each with 80% or more overlap. The anticlinal hill and the gorge from the Betic Cordilleras of southern Spain (plate 6 A & B) are examples of this situation, and it will be noted that for these cases the parallax difference between foreground and background does not exceed 0.75cm, a suitable value for the pocket stereoscope. The percentage overlap is of course determined by the distance between camera stations, and increase or decrease of this distance will increase and decrease the distance exaggeration. It is a fact that on stereopairs such as those of plate 6 much more can be ascertained from the stereoscopic view, than from ground observation from the same viewpoint, since the main areas in the fields of view are beyond the range of the stereoscopic vision of the eyes.

If the points discussed above are adhered to during survey then it clearly becomes possible to make the same type of calculation that can be achieved with aerial photographs. For example use of the stereometer will permit distance calculation of any desired locality. However for most occasions this sort of information will not be essential and, in these circumstances, a quickly taken stereopair may be all that is required, and will still have the tremendous advantages over the single photograph which have been discussed above.



A

B

C

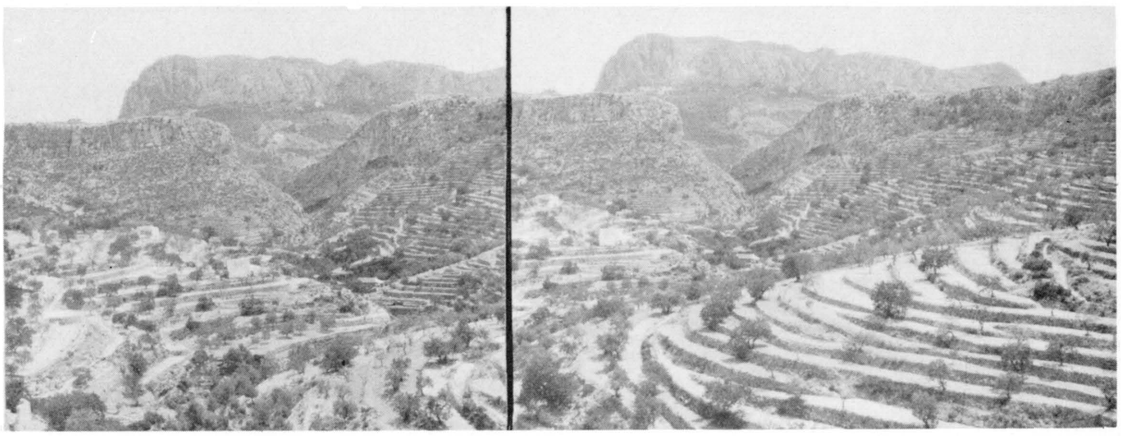
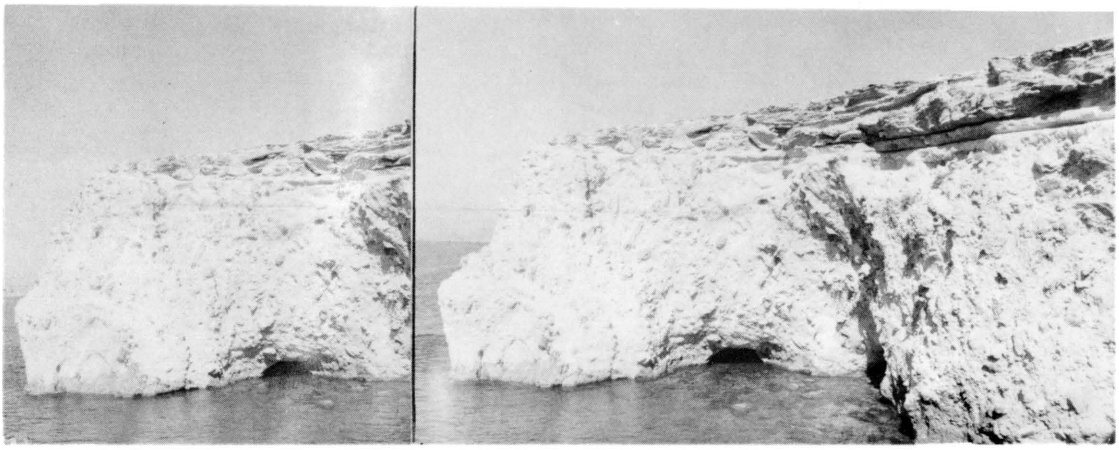


PLATE 6

A. M6 (below) and A685 one mile south of Tebay, Westmorland. The section shows folded Silurian strata, with a small thrust cutting the syncline, and a high angle fault cutting the anticline, joints and drill holes show up clearly to the right of the photograph.

B. Sierra Bernia, Pre-Betic Cordilleras of S.E. Spain. The skyline is of Oligocene limestone and the middle distance is an anticline in Cretaceous limestone. In the foreground Cretaceous marls have a low angle fault contact with the limestone.

C. Pre-Betic Cordilleras, S.E. Spain. The foreground shows an escarpment of Oligocene limestone transected by the antecedent Gorge del Estret. The background is formed by a klippe of Eocene limestone which has been thrust over soft Miocene rocks.



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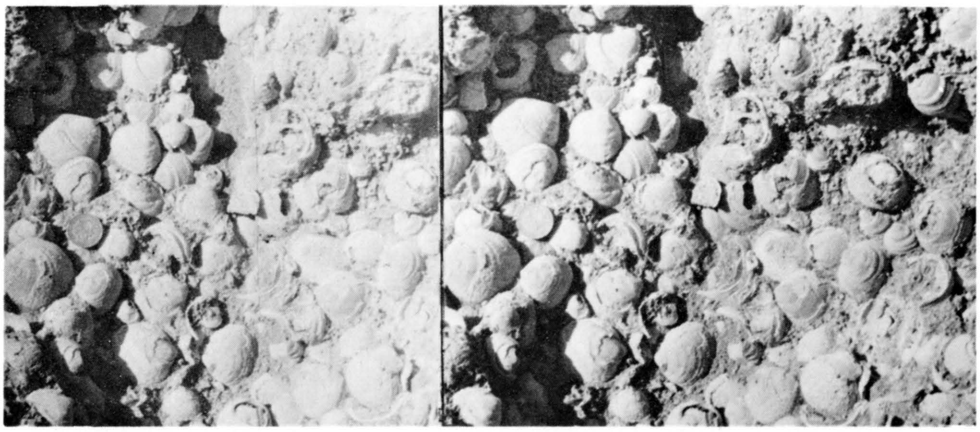

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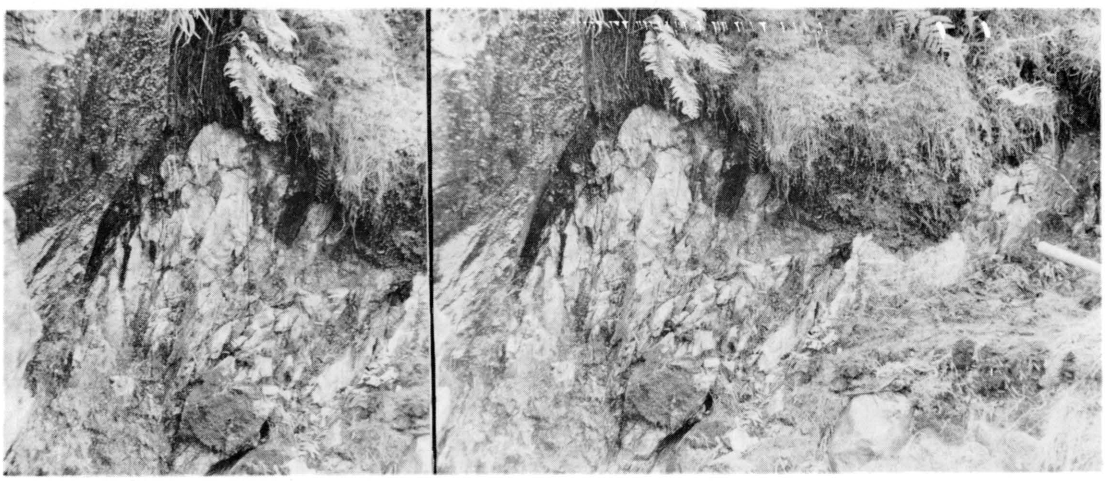

PLATE 7

A. Akrotiri, Cyprus. Miocene boulder beds with crystalline limestone boulders in a chalk matrix, overlain by Pliocene shell sands. The cliff is 60 feet high.

B. Akrotiri, Cyprus. A Pliocene shell bed showing the bedding plane surface, mostly with *Glycimeris* sp.

C. Warnscale Bottom, Cumberland. Tectonic junction between folded Skiddaw Slates and Borrowdale Volcanic rocks. It will be noticed that use of the stereoscope immediately resolves the complex orientations of joints and cleavage in the slates. The white lines are along bedding traces.

Close up stereoscopy

There is no need to repeat those observations above which clearly apply whatever the object distance. Stereo-photographs of quarry faces and natural rock outcrops, whilst they should never be regarded as an alternative to thorough field investigation, are nevertheless useful for recording details of bedding, joints, lithologies and other small scale rock features. It is a common experience that intersecting planar surfaces (particularly joints) can be difficult to visualise and interpret on single photographs. This is especially so where those surfaces make oblique angles to sections of quarry and cliff faces, in which case a confusing picture is generally the result. It is remarkable how readily these features are resolved by steroscopy (plate 7C). The imagination can rapidly multiply other situations where stereo-photographs will be of value, for example where weathered surfaces reveal igneous, sedimentary and metamorphic structures and textures (the scale of the structures may be too large to permit collection of specimens), or likewise important fossils may stand out from a weathered surface, but it may not be possible to collect them without risk of destruction. Stereo-photographs are clearly important in these cases and steromodels of fossils will give greater chance of subsequent identification.

It has been the intention of this paper to draw attention to a little used but perfectly obvious method of field geology. Many possible refinements and extensions will be apparent, especially to photogrammetrists, and there is no reason why any three dimensional surface from a macro to a microscopic scale should not be recorded in this way.

References

ALLUM, J.A.E. 1966. Photogeology and regional mapping. Pergamon, i - xii, 107 pp.

LATTMAN, L.H. and RAY, R.G. 1965. Aerial photographs in field geology. Holt, Rinehart & Winston, i - x, 221 pp.