APPENDIX: THE DATA FOR OROGENIC STUDIES QUESTIONNAIRE

The following pages include in facsimile the original questionnaire on which the data compilation is based.

GEOLOGICAL SOCIETY OF LONDON
Burlington House, Piccadilly, London W.1.

Data for Orogenic Studies

Notes for Contributors

AIMS OF THE DATA FOR OROGENIC STUDIES PROJECT

The most dramatic new discoveries about the structure of the Earth in recent years have been those arising from the investigations of the ocean floors and the deep structure of the Earth (as it now is) by geophysical means. For a long time, however, a much larger bulk of information has been accumulating from the investigations of the continental masses; moreover, this information generally yields evidence of successively earlier stages in tectonic history. It is clearly essential in elaborating geotectonic hypotheses to take into account all the relevant evidence, and failure to do so may, in large measure, be attributed to the difficulty of searching through an enormous bulk of literature on continental tectonics and also to the subjective way in which much of it appears. It therefore seemed appropriate and timely to make available tectonic data aiming at a convenient and objective presentation.

It is intended to compile and analyse data related to the structure and history of about 40 selected Cainozoic and Mesozoic orogenic belts throughout the world, by inviting contributions from those familiar with the various orogenic regions. With their co-operation, representative coverage should be achieved. At the same time, to achieve maximum objectivity and comparability of the contributions, it has been decided to request the data by means of a carefully designed questionnaire which will, so far as possible, provide quantitative or 'yes/no' answers. The possibility of using this information for computer analysis has been kept in mind. Expressions of personal opinion and evaluation are also encouraged, within reasonable limits, and provision is made for this in the questionnaire.

An office has been set up within the Geological Society to co-ordinate the replies and to produce the appropriate maps, sections and diagrams. This information will be published by the Geological Society in a special volume, in uniformly presented and illustrated chapters, each dealing with a segment of one orogenic belt.

NOTES FOR CONTRIBUTORS

GENERAL

a. It is realized that the questionnaire must initially appear very complex. It is hoped that this first impression will prove misleading, as the questionnaire is designed to be completed in short sections which can often be answered independently of each other, and as such should, when familiar, be relatively easy to answer.

b. The questionnaire is designed to elucidate the structure and history of a typical segment* of the orogenic belt. *It is left to the individual contributor to select the most representative segment for this purpose.*

c. Much of the questionnaire relies on the subdivision of the segment into structural zones* and structural elements*. These subdivisions are employed in order to collect detailed data in a systematic manner. They should reflect fundamental or easily recognizable divisions within the segment. It may be necessary to recognize sub-zones (in which case answer all the zone questions for each sub-zone) and/or sub-elements, but in any case the number of zones within a segment should not normally exceed ten. If, however, the answers to a group of questions are the same for a number of zones, they need only be answered once; on subsequent occasions reference back to the previous answers may be made.

d. Some terms (marked*) used in this questionnaire are defined in order to facilitate uniformity of usage between contributors to the project.

ANSWERING THE QUESTIONNAIRE

e. The questionnaire is in three parts. Questions in parts 1 (General data on the orogenic belt and the selected segment) and 2 (Subdivision of the orogenic segment) need only one answer each. Questions in part 3 should be answered for each structural zone (and for each structural element in some cases). For example, if five structural zones are selected, five sets of replies should be provided.

f. Please complete the questionnaire, using the spaces provided and crossing out YES or NO as appropriate, in *blue* or *black ink* (to facilitate photo-copying). Continue on a sheet of blank paper whenever necessary.

g. *It is not expected that all questions will be answerable for every belt.* If the answer to any question is not known, please write NK (Not Known). If any question is inappropriate, please write NA (Not Appropriate). A few words of explanation would be welcome in these cases.

h. Where 'evidence' is requested all that is generally required is a brief statement of the nature and conclusiveness of the evidence, together with references to the literature where it is presented and discussed.

i. If you feel that the answers to any questions are available elsewhere you are invited *either* to enlist the aid of another expert, or to write to Dr A.M. Spencer suggesting people who might be invited to co-operate.

j. For uniformity all measurements should be in metric units. All angles should be in degrees (i.e. azimuths to 360°, dips, etc.). All longitudes should be given from the prime meridian of Greenwich. All maps and profiles should have the scale (in metres or km) clearly marked.

k. Where appropriate, numerical answers may be given in the form > 20 < 70 km or 30 ± 20 km. A dagger (†) may be used to indicate answers subject to considerable uncertainty and a circle and cross (⊗) to indicate data considered very good.

l. Please attempt to give all ages (or their equivalents) according to the enclosed scale, using the abbreviations suggested there. If greater precision is lacking ages may be quoted as 'post-X, pre-Y'.

MAPS AND DIAGRAMS

m. To save contributors' time maps and diagrams may be submitted *in a form ready for final drafting*. This will be undertaken at the Geological Society and will ensure a uniform format for the eventual publication.

OFFPRINTS

n. Spare offprints of any relevant papers would be welcomed for the library of the Geological Society, where they would be available for continuing this work.

AUTHORSHIP

o. Where a group of authors is responsible for the answers in a segment individual responsibility may be indicated at the end by initials and by numbers of questions, e.g. J.R.L. 1–50, 73–83,
P.Q.R. 51–72, 84–91, etc.

The Society asks the contributors to whom the questionnaire is addressed to assume responsibility for deciding if the segment he contributes should be headed by his name alone or whether outside assistance should be recognized by co-authorship or acknowledgement.

REFERENCES

p. A list of references to published work (preferably not more than 50 titles) is requested at the end of this questionnaire. It should include:

(i) References which give a general survey of the region or some aspect of it and which cite other references. References to relevant bibliographies. References to published geological maps. These 'leading' references need not be referred to in the questionnaire but should be distinguished by an R (for review), B (for bibliography) or M (for map), preceding the authors name.

(ii) References to all papers mentioned in the answers to the questionnaire.

(iii) References relating to critical or controversial statements, or to statements which summarize a great deal that may not be otherwise evident. Contributors are asked to cite references in groups (ii) and (iii) where appropriate throughout the answers to this questionnaire, by giving author and year in parentheses. It would avoid delay in processing and publication of the data if all references in the final list were quoted in the style adopted for the publication, which is illustrated by the following list.

CAREY, S.W. 1955. The orocline concept in geotectonics. Proc. R. Soc. Tasm. 89, 255–88.

HOLMES, A. 1927A. Some problems of physical geology and the Earth's thermal history. Geol. Mag. 64, 263–78.

———— 1927B. Oceanic deeps and the thickness of the continents. Nature, Lond. 120, 804–5.

———— 1965. Principles of physical geology, 2nd edn., London (Nelson).

———— & HARWOOD, H.F. 1929. The tholeiite dykes of the north of England. Mineralog. Mag. 22, 1–52.

LADD, H.S., TRACEY, J.I. Jr., WELLS, J.W. & EMERY, K.O. 1950. Organic growth and sedimentation on an atoll. J. Geol. 58, 410–25.

PANCHEN, A.L. 1967. Amphibia. In HARLAND, W.B. et al. (Eds.) The Fossil Record. London (Geological Society), pp. 685–94.

RICHTER, D. 1961. Die δ – Achsen und ihre räumlich-geometrischen Beziehungen zu Faltenbau und Schiefrigkeit. Geol. Mitt. Aachen, 2, 1–35.

SHEINMANN, YU.M. 1961. [Mohorovičić discontinuity, depth of magma generation and distribution of ultrabasites.] Sov. Geol. 1961 (8), 31–44 [in Russian].

TECTONIC MAP OF INDIA (SCALE 1:2 000 000). 1963. Delhi (Geological Survey of India).

DEFINITIONS

Definitions for phrases marked with an asterisk (*) in the questionnaire are given below.

Orogenic belt. A well defined area (measurable in tens of thousands of square kilometres) which has shown, or is showing, marked mobility typically characterized by the development of deformation structures (e.g. folds, foliations, lineations and reverse, thrust and transcurrent faults). The belt may also have been affected by regional metamorphism and magmatism and has undergone or may be undergoing uplift and sub-aerial erosion.

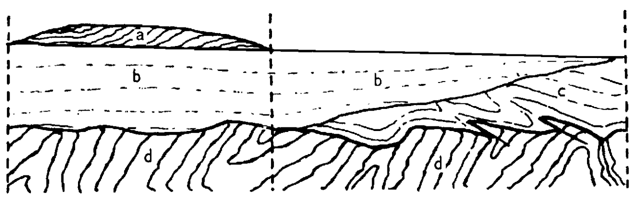
Segment. A part of an orogenic belt selected by the contributor which, if possible, extends across the belt on to adjacent non-orogenic areas and is sufficiently well studied to allow adequate characterization by the questionnaire.

Structural zones are conveniently chosen stratigraphic-tectonic units, the geographical boundaries of which may be shown as lines on a map and which include rocks of all structural levels within the geographical limits of the zone. The boundaries of zones will normally be drawn in such a way that they separate areas between which the difference in surface geology and structural style are sufficiently great for them to be usefully described separately at the scale of study (approximately 1:2,500,000). Zones will commonly trend parallel to the length of a belt.

Structural elements are used to describe, within a zone, the different patterns of deformation that may have developed at different tectonic levels, or the large rock masses that may be transported laterally and come to rest upon rocks of quite different tectonic character. An element is a unit within which deformation has been continuous and/or homogeneous on the scale of this study. There will be some kind of structural or stratigraphical discontinuity between adjacent elements. The same elements may be recognized in one or more structural zones.

To make their use clear, an example of the application of structural zones and elements is given below, using a diagrammatic tectonic profile; crosses are used to indicate the distribution of elements between zones.

Element ▼ ZONE ▶	1 'Outer' Zone	2 'Inner' Zone
a. 'Allochthonous Jurassic'	X	
b. 'Molasse'	X	X
c. 'Autochthonous Jurassic'		X
d. 'Metamorphic basement'	X	X



Basement. The structural element (or elements) showing evidence of movements and/or metamorphism completed prior to those in the orogeny investigated in the main part of this questionnaire and characterized by a distinct structural pattern differing from that of the orogenic belt for which the questionnaire is answered.

Undeformed, for this purpose, refers to rocks folded with an amplitude/wavelength ratio of less than say 1/20, or only folded very locally, or tilted less than say 10°, or only moderately faulted.

Mobility. Continued movements of the lithosphere involving either elevation, depression or lateral movement of parts of the crust of the order of 1 km in 10^7 years or faster, assessed by either deposition or erosion of sedimentary piles, or by development of tight folding, or by thrusting, or by strike-slip faulting or (in some cases) by metamorphism.

Orogeny. A period or interval (of the order of 200 million years) during which continuous or intermittent tectonic deformation (tectonization) or mobility contributed towards the evolution of an orogenic belt.

Phase of metamorphism. Periods of intervals, of any duration, during which particular mineral assemblages were generated.

Metamorphic zones. Zones defined by the appearance or disappearance of particular mineral species or assemblages.

Phase of deformation. Distinct periods or intervals, of any duration, during which any or all of the following were formed: folds, foliations, lineations and reverse, thrust and strike-slip faults.

Definitions of other terms, for example those used in fold nomenclature (question 355) or terms which might be recommended for the description of planar structures, have not been produced. Definitions for such terms can be found in: DENNIS, J.G. 1967. **International Tectonic Dictionary** (Memoir 7, American Association of Petroleum Geologists).

SCHEME FOR THE DESCRIPTION OF FOLD SHAPES (question 356)

(by P. J. Hudleston, Imperial College, London)

This is a classification of single-folded surface geometry (i.e. the geometry of a boundary separating two layers) based on harmonic (Fourier) analysis. It can be shown that for a given amplitude a continuous spectrum of shapes exists between two end members, the 'box-fold' and the 'chevron-fold' models. Six distinct shapes within this spectrum have been selected, all of which have been drawn at five different amplitudes, giving 30 possible combinations of shape and amplitude in a cross-reference scheme for classification (Fig. 1). Most natural fold shapes can be allotted a position in this classification. This may be done by **observing fold surfaces seen on photographs through the transparent diagram (Fig. 1)** and finding the closest match; the comparison is independent of size.

The complete procedure for matching shapes using photographs is explained below and a worked example is given on the following page:

1. Observe the folds in profile, looking down the fold axis (Fig. 2).
2. As most folds are asymmetrical each quarter wavelength (i.e. between inflexion point and hinge point) is considered and matched separately (for this reason a quarter wavelength of the classified shapes has been drawn in heavy line on Fig. 1).
3. Each segment, from inflexion point to hinge (Fig. 3), is visually compared with the classified shapes (Fig. 1) and the closest fit found for each. The result may be indicated by marking the appropriate square in the diagram beneath question 356 (see Fig. 4).
4. As the shapes of a single layer for different folds and for inner and outer arcs can show considerable variation a fair number of quarter wavelength segments need to be matched to obtain a representative estimate of shape.
5. The procedure needs to be repeated for several representative photographs for each deformation phase in each element. Once the contributor has become familiar with the procedure, however, analyses of a sufficient number of photographs should be achieved quite rapidly.

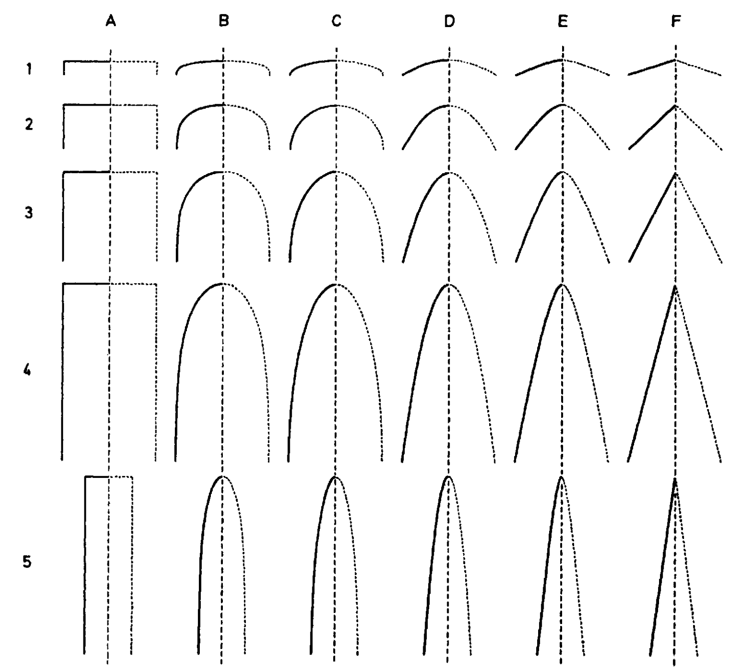


FIG. 1

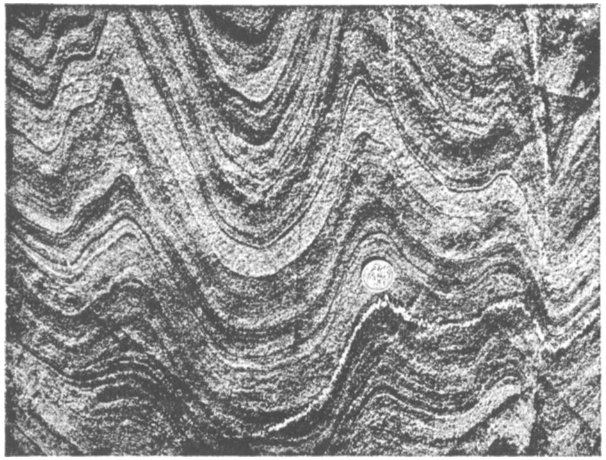


FIG. 2.

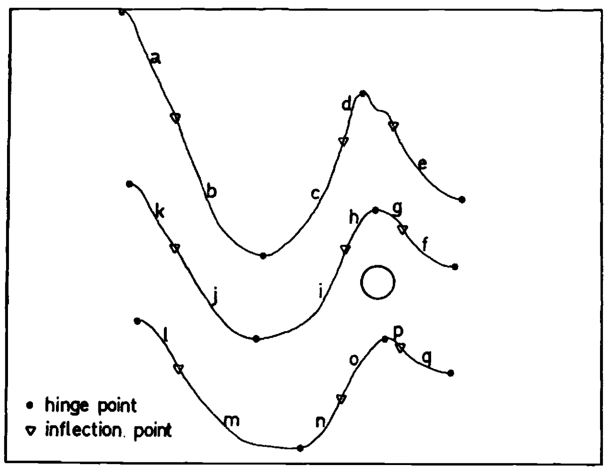


FIG. 3.

	A step function (box fold)	B	C semi-ellipse	D parabola	E	F saw-tooth wave (chevron fold)
1				q		
2			i, m	e, f, g, j, l, n, p		
3				b, c, h, o	a, d, k	
4						
5						

FIG. 4.

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Data for Orogenic Studies

Questionnaire Parts 1 & 2

Name of belt: ______________________

Full name of contributor: ______________________

Full postal address of contributor: ______________________

____

____

1. GENERAL DATA ON THE OROGENIC BELT* AND THE SELECTED SEGMENT*

1. DEFINITION OF THE AREA OF STUDY: THE SEGMENT

A. 1. A map is requested, suitable for reduction to not more than a page measuring 13cm by 19cm, designed to show (i) the position of the selected segment* in relation to the orogenic belt*, (ii) the boundaries of the structural zones* and (iii) those structural elements* and major faults (question W) that can be distinguished on this scale. (iv) Scale, lines of latitude and longitude, major coastlines and place names used may also be usefully included.

B. 2. **Name of the orogenic belt** ______________________

Names of the *margins* of the belt against non-orogenic areas (for example, inner, outer, or northern, southern . . .) –

3 margin μ ______________________

4. margin β ______________________

5. Average *width across the belt* in the segment (measured across the strike ______________________ km

6. *Length of the segment* chosen (measured along the strike) ______________________ km

C. Character of the selected segment –

7 *Simple* orogenic belt*, containing rocks deformed during only one post Pre-Cambrian orogeny . . . . . . YES NO

8 A *multiple* orogenic belt, that is one in which all the features formed during one orogeny*, but in which belt(s) of undeformed rock occur . . . . . . YES NO

9 A belt including rocks deformed during more than one post Pre-Cambrian orogeny . . . . . . YES NO

Please comment on the above questions and answers:

* Asterisks refer to terms defined in the *Notes for Contributors* which accompanies this questionnaire.

II. SURFACE SHAPE OF THE OROGENIC BELT IN PLAN

D. The **margins of the belt** in the segment are –

	margin μ		margin β	
10 sharply defined (within ½ km)	YES	NO	YES	NO
11 narrowly gradational (½ to 3 km)	YES	NO	YES	NO
12 broadly gradational (over more than 3 km)	YES	NO	YES	NO
13 indefinite owing to structural or stratigraphical uncertainties or because of lack of exposure	YES	NO	YES	NO
14 oceanic trench	YES	NO	YES	NO
15 in dispute	YES	NO	YES	NO

E. 16. The belt as a whole is observed to continue along the strike beyond the sides of the segment chosen for description . . . YES NO

If NO, **17** passes out to sea . . . YES NO

18 terminates at a stable block . . . YES NO

19 dies out gradually . . . YES NO

20 passes beneath another belt . . . YES NO

21 is concealed by later rocks . . . YES NO

F. The general trend of the whole orogenic belt, including that particular part selected as the segment under study, follows some geometrical pattern, for example –

22 great circle . . . YES NO

23 arc or series of arcs . . . YES NO

24 other (please specify) . . . YES NO

Give, **25** the approximate length of the belt described in questions **22** to **24**

(measured parallel to its trend) ____________ km

26 the length(s) of radius (radii) of curvature of principal arc(s):

____________ km, ____________ km

G. Width of the orogenic belt, excluding undeformed flanking sediments, in the whole area described in questions **22** to **25** –

27 average width ____________ km

28 maximum width ____________ km

29 minimum width ____________ km

III. SURFACE SHAPE OF THE SEGMENT IN ELEVATION

H. Elevation above sea-level of –

30 the highest 5% of the ground within the orogenic part of the segment

(to nearest 500m) ____________ m

31 Margin μ ____________ m

32 margin β ____________ m

I. Have **geomorphological surfaces** been recognized –

33 by summit heights on relict peneplains . . . YES NO

If YES, please give the height range and age (with evidence) of each surface:

34 at lower levels . . . YES NO

If YES then, **35** at how many levels ____________

and **36** please give the height range, age and evidence for the age for each surface:

J. 37. Please quote references to published profiles which illustrate any of the points in questions H and I:

IV. GEOPHYSICAL DATA – THE DEEP STRUCTURE OF THE SEGMENT

K. Gravity data are available –

38 within the segment . . . . . . YES NO

39 nearby and relevant to the segment . . . . . YES NO

40. Please attach sketch maps, which may extend outside the segment, with 10 milligal contours of Bouguer and Isostatic anomalies, or quote references of such published maps:

41. Is the segment in approximate isostatic equilibrium . . . YES NO

Is the general gravity field concordant with –

42 the main tectonic trend . . . . . . YES NO

43 the main topographic trend . . . . . . YES NO

44. Please give references to relevant literature:

L. Regional magnetic data (excluding palaeomagnetic) are available –

45 within the segment . . . . . . YES NO

46. Please attach a sketch map with 200 gamma contours, if available, or quote references to such published maps:

Are the anomalies concordant with –

47 the main tectonic trend . . . . . . YES NO

48 the main topographic trend . . . . . . YES NO

49. Please give references to relevant literature:

M. Regional seismic data are available –

50 within the segment . . . . . . YES NO

51 nearby and relevant to the segment . . . . . YES NO

Type of survey (mark where appropriate) and depth of penetration or analysis –

52 refraction shot one way only . . . . . YES NO _____km

53 refraction shot with reversed profile . . . . . YES NO _____km

54 deep reflection survey . . . . . . YES NO _____km

55 surface-wave studies . . . . . . YES NO _____km

56. If possible, please supply a profile (quote position, orientation and type of survey) showing low- and high-velocity layers (with P-wave velocity) and depths to velocity discontinuities, or give reference to published profiles:

57. Can the **Mohorovičić discontinuity** be recognized . . . . YES NO

If YES, then **58** depth to M-disconinuity (if variable then show on profile only) . . . . . . _______km

59 P-wave velocity at base of crust . . . . _______km/sec

60 sub-Moho P-wave velocity . . . . . _______km/sec

If NO, then **61** please say why (for example, survey had inadequate penetration, or Moho does not exist . . . . .):

Is a **low-velocity layer in the upper mantle** suspected or known to exist (specify whether for P- or S-waves or both) –

62 suspected but data not available . . . . . . YES NO

63 known . . . . YES NO

64 depth to upper boundary for P-waves_______________km, for S-waves _____________km

65 depth to lower boundary for P-waves _______________km, for S-waves _____________km

66. Please give references to relevant literature:

N. If **palaeomagnetic data** are available within or near the segment then –

67 please give references:

V. PRESENT DAY ACTIVITY IN THE SEGMENT

O. 68. Is the region currently **seismically active** . . . . . . YES NO

If YES, then **69** if *highly active* (frequent earthquakes with magnitudes greater than 3), attach a sketch map and profile showing the location of epicentres and illustrate the magnitude, or quote references to published maps and profiles:

or **70** if *less active*, complete the table for earthquakes in the last 25 years, if appropriate –

Latitude of epicentre	longitude of epicentre	depth of focus	magnitude	fault plane solution

71. Please give references of papers which review seismic activity:

P. If **heat flow** records are available within the segment please complete the table –

72 latitude and longitude of observations	**73** heat flows	**74** references

Q. 75. Is there evidence of the amount and rate of **uplift, subsidence or lateral movement,** if any, **in historical time** (for example, geodetic measurements) . . . . YES NO

If YES, please give references and/or details:

VI. TIME RELATIONS

Give (in brackets) the local name of the critical formation on which time relations depend. So far as possible convert their ages to the scale provided, except in the case of Pre-Cambrian rocks, whose apparent isotopic age should be given, if known.

R. Basement rocks (see definition*) are known to exist –

76 within the orogenic part of the segment . . . . . YES NO

or **77** within 100 km on either margin of the orogenic part of the segment: margin μ YES NO, margin β YES NO

The *'age' range of basement rocks* present –

78 within the orogenic part of the segment is from ______

to ______ age. Criterion of age (e.g. fossils, isotopic dates) ______

79 within 100 km of margin μ is from ______

to ______ age. Criterion of age ______

80 within 100 km of margin β is from ______

to ______ age. Criterion of age ______

S. 81. The **oldest rocks deformed for the first time** during the last orogeny*

(______ Formation) are ______ age.

82. The evidence for this age is (reference ______)

83. The **youngest deformed rocks** (______ Formation) are

______ age. **84.** The evidence for this age is

(reference ______)

85. The **oldest undeformed* rocks** within the orogenic belt in the segment (______ Formation) are ______ age.

86. The evidence for this age is (reference ______)

T. If the **initiation of mobility*** associated with the last **orogeny*** can be recognized please

give – **87** locality ____________________

88 a youngest rocks folded (if applicable) ____________ and

88 b probable age of initiation of mobility ____________

and evidence –

give **89 a** probable age of cessation of mobility ____________ and

89 b oldest rocks not folded (if applicable) ____________

and evidence –

If the initiation of mobility cannot be recognized, **90** please explain why –

U. If **distinct phases of mobility*** (relatively brief periods of time, of the order of 5 million years, when mobility* was particularly in evidence) can be recognized after the onset of Mesozoic-Tertiary mobility, please complete the table for each phase (1, 2, 3, 4, etc.) –

	91 phase name (if any) and/or locality	**92** nature of mobility	**93** maximum age (beginning of phase)	**94** minimum age (end of phase)	**95** nature of evidence for ages

If distinct phases of mobility cannot be recognized then –

96 please say why not (e.g. mobility continuous . . . .):

VII. SEDIMENTARY RELATIONSHIPS

(It is suggested that contributors leave answering this section until they have answered the zone questions)

The following definition should be used. **Pre-orogenic:** sedimentation which post-dates the production of basement rocks (as defined in question **78**) but prior to the initiation of mobility (as defined in question **88b**). **Syn-orogenic:** sedimentation from the initiation of mobility (question **88b**) up to and including the sediments described in question **83**. **Post-orogenic:** the oldest undeformed sediments (as defined in question **85**) and all younger sediments.

V. Please list as much as practicable of the following data –

		In the orogenic belt in the segment			Syn- and Post-orogenic sedimentation within 50 km outside the margins of the orogenic part of the segment	
		Pre-orogenic	Syn-orogenic	Post-orogenic	Outside margin μ	Outside margin β
97 age span from						
to						
98 maximum thickness		m	m	m	m	m
99 estimated volume per 100 km length of segment		km³	km³	km³	km³	km³
and probable error in this estimate		%	%	%	%	%
100 dominant facies (if any)						
Percentage of the total volume occupied by – and the error	**101** dominant facies	± %	± %	± %	± %	± %
	102 volcanic rocks	± %	± %	± %	(hatched)	(hatched)
	103 sedimentary rocks with over 90% carbonate	± %	± %	± %	(hatched)	(hatched)
	104 sedimentary rocks with over 95% quartz	± %	± %	± %	(hatched)	(hatched)
105 source area of sediments		(hatched)	(hatched)	(hatched)		

106. Have the *effects of deformation* been taken into account in question **98** . . . . YES NO

If YES to **106**, please explain briefly how this was done

If NO to **106**, please comment whether this was impractical ______________________

or unnecessary ______________________

107. Was *sedimentation apparently continuous* throughout the pre-orogenic and syn-orogenic periods . . . . . . YES NO

108. Please list the ages of any *major erosion surfaces* within the sediments:

109. Please provide a diagram, for eventual reduction to 65 mm by 95 mm, on which is shown the general positions of the main pre-, syn- and post-orogenic basins, if possible with directions of sediment transport.

110. If possible, provide a diagrammatic cross-section of the segment showing the original thickness variation of the sediments.

VIII. STRUCTURAL RELATIONSHIPS

W. Faulting. Please list the characters of each major fault within the segment which either *traverses more than one structural zone*, or which *separates zones* –

111 name (if any)	**112** age of commencement			**113** age of cessation			**114** type of movement and their directions	**115** amount of displacements	**116** associated with mylonite or pseudotachylite
	maximum	minimum	probable	maximum	minimum	probable			

117. Please list the type of evidence used to assess **115** for each fault –

118. On the map requested in question **1**, or on a separate map if need be, please indicate the faults discussed above.

X. Is it possible, or have any attempts been made, to establish any **relative displacement of opposite sides of the whole belt** from the offset of –

119 ancient orogenic belts on both sides of the belt . . . . . YES NO
120 dyke swarms . . . . YES NO
121 regional magnetic anomaly patterns . . . . . . YES NO
122 palaeoclimatic indicators . . . . YES NO
123 palaeomagnetic data . . . . YES NO
124 transcurrent faults . . . . YES NO
125 physiographical features . . . . YES NO

If YES to any of **119** to **125** please summarize briefly with references:

IX. GENERAL

Y. It would be helpful if you would comment (preferably not more than 250 words per question, except **134**) on any of the following which are of special interest in the area under study –

126 Regional chronology and correlation
127 The migration of troughs of sedimentation
128 Regional vertical movements, deduced from, for example, the use of a structure-contour map of an extensive contemporaneous sedimentary horizon which was originally deposited at sea-level or formed close to sea-level, for example the unconformable surface of a marine transgression
129 Rates of movement in the orogeny
130 Palinspastic reconstructions (see question **110**)
131 Erosional factors in relation to the volume of syn- and post-orogenic sediments within and adjacent to the segment (question **99**) and the sources of those sediments (question **105**)
132 Geophysical evidence of orogenic structure
133 Effects of transcurrent or strike slip faulting
134 The overall evolution of the belt
135 Any critical information not elicited by the questionnaire.

Z. 136. Please provide a *composite* natural-scale (or if need be diagrammatic) **profile across the belt.**

2. SUBDIVISION OF THE OROGENIC SEGMENT

The belt may be divided into Structural Zones*, within which are Structural Elements*. The latter may be common to more than one Zone (see definitions).

A. 201. Please **name all Structural Zones and all Structural Elements** within the selected segment on the following table and indicate by crosses (x) which Elements occur in which Zones –

Zone names	1	2	3	4	5	
Element names						
a						
b						
c						
d						
e						

B. 202. For **each Structural Element occuring in more than one structural zone** give basis for correlation (continuity, palaeontological or isotopic age, lithology, metamorphic grade, etc.):

C. 203. If it has not been possible to show the elements on the map requested in question **1**, then, in order to ensure that the compilers of the volume appreciate the structural relationships, it would be helpful if you would supply a rough map (not for publication) showing *all* the elements in the selected segment.

GEOLOGICAL SOCIETY OF LONDON
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Data for Orogenic Studies

Questionnaire Part 3

Name and number of Structural Zone: ______________________

____

(Part of belt: ______________________**)**

3. DATA ON INDIVIDUAL STRUCTURAL ZONES

A. 301. Zone name ______________________ and number ____________
(as in question **201**).

(i) GENERAL

B. The *margins* of this zone are –

302 sharply defined (within ½ km)	YES	NO
303 narrowly gradational (½ to 3 km)	YES	NO
304 broadly gradational (over more than 3 km)	YES	NO
305 indefinite owing to structural/stratigraphical uncertainties . .	YES	NO
306 indefinite because of lack of exposure	YES	NO
307 in dispute	YES	NO

C. Give the *approximate area of the zone occupied by the outcrop* of –

308 volcanic rocks ____________ %
309 plutonic rocks ____________ %
310 sedimentary rocks ____________ %
311 metamorphic rocks ____________ %

(ii) ELEMENTS IN ZONE (   )

For each structural element occuring in this zone answer, where possible, questions **312** to **317**

D. General features of the elements –

element name	312 briefly indicate the lithology and structural character	313 estimate any net change in shape and volume accomplished during the orogeny investigated in this questionnaire – comment as necessary	314 nature of the contacts of the element against adjacent elements within this zone (e.g. strike-slip faults, unconformities . . . .)
a			
b			
c			

E. Dimensions of the elements:

	315 length				316 width				317 thickness			
	exposed				exposed				exposed			
	maximum	minimum	average	‡	maximum	minimum	average	‡	maximum	minimum	average	‡
Element name												

‡ total dimension, including possible sub-surface and eroded supra-surface continuation. Please list, if appropriate.

F. 318. Please attach a profile showing the distribution of structural elements within this zone.

(iii) STRATIGRAPHY IN ZONE (   )

G. Summarize in stratigraphical order (youngest at the top) **the character of the main sedimentary formations or groups** (including bedded volcanic rocks) **within the zone**; formations or groups less than 500 m thick should be grouped within adjacent units unless of particular importance –

319 formation or group name	320 age and type of evidence for age	321 lithology (generalized)	322 thickness			323 element(s) in which these rocks occur	324
			maximum	minimum	average		‡

‡ Note if 1st cycle (1) or multicycle (2). 1st cycle are rocks deformed for the first time in this orogeny, 2nd cycle are rocks deformed in previous orogenies

(iv) IGNEOUS ACTIVITY IN ZONE ( )

H. 325. Has **igneous activity** occurred within the zone at any time between 200 million years before the initiation of mobility (questions **88** and **89**) and the present . . . YES NO

If YES, please complete both the tables below (enter a number from question **326** in the appropriate box in the second table) –

326 episode of activity	**327** element affected	**328** age (including relationships to deformation)	**329** nature of evidence for age	**330** approximate volume within the orogenic part of the segment ‡	**331** other information (e.g. submarine, depth of emplacement, strike of dykes, etc.)
(oldest)					
1					
2					
(youngest)					

‡ give nearest value (km³): 0.5, 1, 5, 10, 50, 100, 500, 1000

332 a.	Acid	Alkaline	Intermediate	Basic	Ultrabasic
Dykes					
sills					
major intrusions					
lavas and tuffs					
other (specify)					

332 b. Comment on the distribution of igneous rocks within the zone (for example, are ophiolites present on the inner and outer margins):

(v) METAMORPHISM IN ZONE (')

I. 333. Has **metamorphism of any kind** affected the zone at any time . . YES NO

If YES, **334** can distinct **phases of metamorphism*** be recognized . . YES NO

If **334** YES, please complete the table for each phase –

335 name and/or number of phase	**336** element affected	**337** age			**338** evidence for age	**339** mineral assemblage in observed		**340** rank of coal	**341** suggested metamorphic facies and if appropriate their horizontal and vertical distribution
		maximum	minimum	probable		basic rocks	pelitic rocks		
(oldest)									
1									
2									
(youngest)									

342. Please provide a map of isograds, or give reference to such a published map, and comment on shape differences, if any, between the original and present three-dimensional shapes of the metamorphic zones*.

(vi) DEFORMATION IN ZONE (   )

J. **343.** Is one or more **phase of deformation*** recognizable within the zone . . . . YES NO
If YES, please complete the table below separately for each phase –

344 name and/or number of phase	345 element(s) affected	346 nature of the deformation	347 age			348 evidence of age
			maximum	minimum	probable	
(oldest)						
1						
2						
(youngest)						

K. **349.** Are **fold structures** present in any element in this zone . . . YES NO
If YES, please complete the table below separately for each element and for each period of folding in each element –

350 number of deformation phase and element name from questions 344 and 345	351 average amplitude (wave height)	352 average wavelength	353 average number of folds larger than 1000m in a cross-section of the element or zone	354 typical apical angle	355 orientation of axial surface, younging and vergence directions
	alternatively indicate the scale thus: > 1000m, 1000–100m, 100m–1 cm, < 1cm				
1, element g					
2, element b					
(etc.)					

356. With reference to the diagram, explanation and worked example provided, indicate the **styles of the folds** developed in each element during each deformation phase by marking the following table. Place the appropriate deformation number and element letter (from question **350**) in the appropriate square for each quarter-wavelength observation made –

	A step function (box fold)	B	C semi-ellipse	D parabola	E	F saw-tooth wave (chevron fold)
1						
2						
3						
4						
5						

357. Please give reference to published maps which show the geographical distribution of folds within the zone, especially any which indicate their relative intensities, axial trends and plunges:

L. **358.** Are **planar or linear structures** associated with the folding . . . YES NO
If YES, please complete the table –

359 number of deformation phase and element name from questions 344 and 345	360 type of structure	361 comment on the time and space relations with the folding	362 references to relevant papers

363. Please sketch the planar structures on cross-sections of the folds with which they are associated

M. **364.** Has strain analysis been carried out on deformed fossils, pebbles, etc. . . YES NO
If YES, then **365** please give references to relevant papers and comment on important results:

(vii) FAULTING IN ZONE ( )

In so far as ***important faults*** may occur between elements, or cutting across elements, they should be dealt with in question **111 – 118.** The purpose of this question is to investigate ***groups of small faults*** not already examined and which, though individually small, may have a large cumulative displacement or other regional significance.

N. Please complete the table for **each period of faulting** and **each group of faults of similar age and character –**

366 age	**367** elements affected	**368** types of faults	**369** relative frequency of different fault types	**370** average orientation	**371** average inclination	**372** estimated crustal displacement throughout the zone, related to faulting; give amount and direction

373. Please comment on the evidence for the age(s) of the period(s) of faulting of zone ( ), and on the estimated shortening, extension, displacement, etc., during the period(s):

374. Please indicate on the map requested in question **203** (or on a separate map if need be) the more important faults discussed above, or give reference to published maps which show the geographical distribution of faults within this zone: