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WORKSHOP ON PATTERN RECOGNITION AND ANALYSIS OF SEISMICITY

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FORMAL MORPHOSTRUCTURAL ZONING

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These are preliminary lecture notes, intended only for distribution to participants.
Missing copies are available from Room 230.

LINEAMENT - A STRAIGHT LINE, OR ACTIVE LINE, DETERMINED BY POINT
ANALYSIS OF

GEOLOGICAL DATA

GEOMORPHOLOGICAL DATA

GEOPHYSICAL DATA ON THE STRUCTURE OF LITHOSPHERE

PHOTOS FROM COSMOS

DIFFERENT PARTS OF A LINEAMENT MAY BE EXPRESSED IN DIFFERENT SETS OF DATA.

"TECTONIC FAULT" ON TECTONIC MAPS USUALLY REPRESENTS THOSE PARTS
OF A LINEAMENT, WHICH ARE EXPRESSED IN GEOLOGICAL DATA. FOR YOUNG FAULTS
THESE DATA ARE OFTEN UNSUFFICIENT.

DITTO - ANY OTHER KIND OF DATA SEPARATELY.

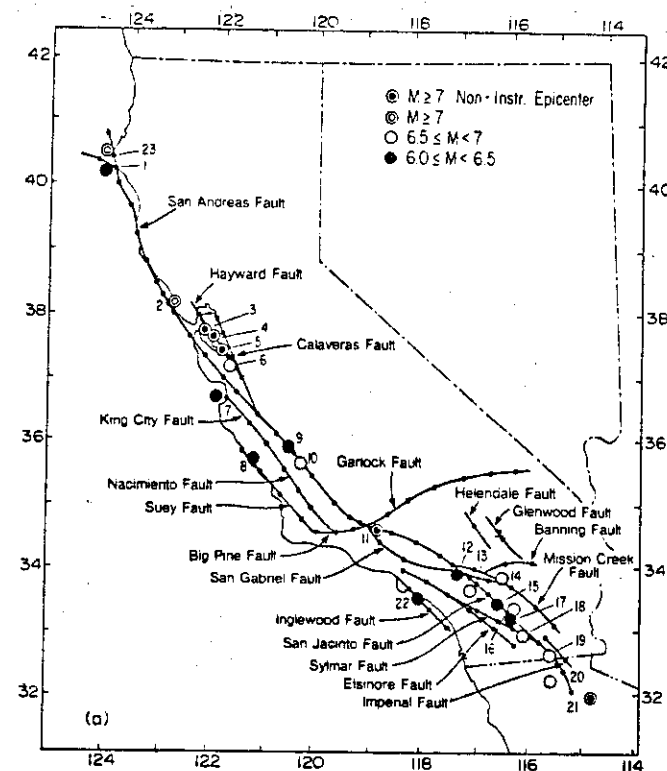
PHOTOS FROM COSMOS SHOW TOO MANY LINES; THEIR NEOTECTONIC
SIGNIFICANCE SHOULD BE ESTIMATED, ALLOWING FOR OTHER DATA.

THE PROBLEM: TO DETERMINE ACTIVE LINEAMENTS OF A REGION IN OBJECTIVE
AND REPRODUCIBLE WAY.

THE IDEA OF SOLUTION: FIRST - TO RECOGNIZE THE BLOCKS INTO WHICH
THE REGION IS DIVIDED;

SECOND - TO OUTLINE THEIR BOUNDARIES WHICH
ARE THE LINEAMENTS.

ADVANTAGE: MORE INFORMATION IS USED ; MORE RELIABLE CONCLUSIONS.



SCHEME OF MAIN FAULTS

FORMALIZED MORPHOSTRUCTURAL ZONING

FORMALIZATION IS ORIENTED TO MAKE REPRODUCIBLE THE CONCLUSIONS OF AN EXPERT. IT IS NOT SUFFICIENT FOR AUTOMATION, SINCE MANY ELEMENTARY DEFINITIONS REMAIN INTUITIVE, SUCH AS "VALLEY" OR "OROGENESIS".

BASIC DEFINITIONS

MORPHOSTRUCTURE - THE STRUCTURE IN THE LITHOSPHERE (OR ITS UPPER PART), EXPRESSED IN TECTONICS AND/OR MODERN TOPOGRAPHY.

MORPHOSTRUCTURAL ZONING - DIVISION OF A TERRITORY INTO HIERARCHICALLY ORDERED SET OF MORPHOSTRUCTURES. THEY ARE OF THREE DIFFERENT TYPES:

VOLUME (AREA ON A MAP) - A PART OF LITHOSPHERE WITH COMMON FEATURES, INDICATING COMMON HISTORY - IT DEVELOPED FOR SOME TIME, AS AN ENTITY AND IN DIFFERENT WAY, THAN SURROUNDING VOLUMES.

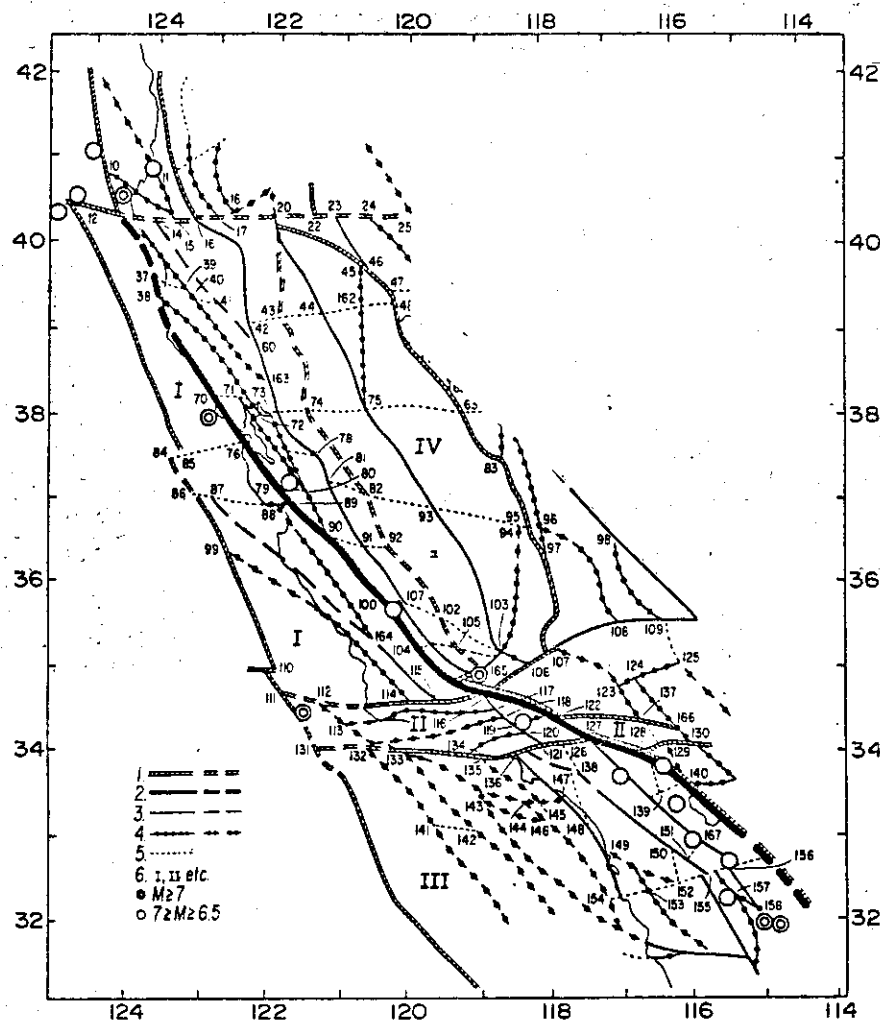
LINEAMENT - LINEAR ZONE BETWEEN AREAS

KNOT - A ZONE OF INTENSIVE AND CONTRAST DEVELOPMENT AROUND INTERSECTION OF LINEAMENTS

AREAS

FOLLOWING DIVISION WAS INTRODUCED FOR REGIONS OF HIGH NEOTECTONIC AND SEISMIC ACTIVITY:

MOUNTAIN COUNTRY (1st RANK) CONSISTS OF MEGABLOCKS (2nd RANK), WHICH CONSIST OF BLOCKS (3d RANK)



MORPHOSTRUCTURAL SCHEME

BLOCK: A COMPLEX OF LARGE ELEMENTS OF TOPOGRAPHY (MOUNTAIN RIDGES AND MASSIVES; INTER-, FORE- OR INTRAMOUNTAIN BASINS; VALLEYS; PLATEAUS; HIGHLANDS; WATER BASINS).

THEY ARE MERGED INTO A BLOCK, IF ELEMENTS OF THE SAME TYPE HAVE SIMILAR QUANTITATIVE CHARACTERISTICS, SUCH AS:

AGE OF OROGENESIS
AVERAGE ALTITUDE (OF AXIS OR BOTTOM)
WIDTH
STRIKE OF AXIS
THICKNESS OF SOFT SEDIMENTS

"SIMILAR" MEANS WITHIN GIVEN LIMITS (6 GRADES FOR OROGENESIS; 10% FOR ALTITUDES ETC).

THIS INDICATES A COMMON NEOTECTONIC HISTORY. BOUNDARY OF A BLOCK IS MARKED BY THE CHANGE OF THESE CHARACTERISTICS.

MEGABLOCK: A COMPLEX OF BLOCKS WITH COMMON DEVELOPMENT SINCE OROGENESIS AND REGULAR AND GRADUAL CHANGE OF QUANTITATIVE CHARACTERISTICS.

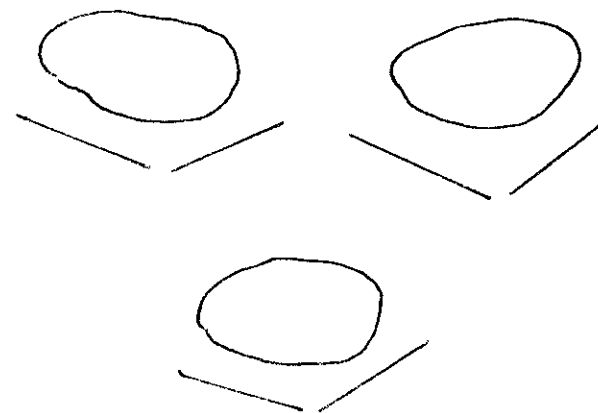
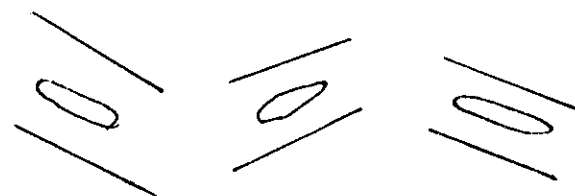
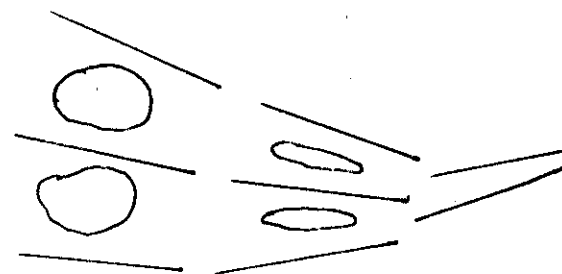
EXAMPLES OF ALLOWED CHANGES:

MONOTONOUS CHANGE OF ALTITUDES ALONG OR
ACROSS THE STRIKE OF PARALLEL RIDGES.

MONOTONOUS CHANGE OF THE WIDTH OF
DEPRESSIONS - ALONG THEIR CHAIN, OR ACROSS
THE STRIKE OF PARALLEL ELONGATED ONES

GRADUAL CHANGE OF STRIKE OF ELONGATED ELEMENTS,
LEADING TO SPECIFIC REGULAR PATTERNS - "FANS",
"ZIGZAGS" ETC.

— RIDGES
○ BASINS



MAIN PATTERNS OF MEGABLOCK GEOMORPHY

MOUNTAIN COUNTRY: A SET OF MEGABLOCKS WITH COMMON TYPE OF OROGENESIS AND PATTERN OF TOPOGRAPHY.

TYPES OF OROGENESIS:

VOLCANIC,
EPIPLATFOMAL,
EPIGEOSINCLINAL,
CONTINENTAL RIFTS.

PATTERN OF TOPOGRAPHY:

RANGE OF ALTITUDES: LOW ($< 1,5$ km),
AVERAGE ($1,5 - 3,5$ km)
HIGH ($3,5 - 5,5$ km) OR HIGHEST.

ALTERNATION OF CERTAIN ELEMENTS OF RELIEF:
RIDGES AND VALLEYS; PLATO AND MASSIVES ETC

TYPE OF MOUNTAINS IS USUALLY CORRELATED WITH THE TYPE AND AGE OF OROGENESIS AND WITH CORRESPONDING CONSOLIDATION OF ROCKS. For example, folded mountains are typical for epigeosinclinal orogenesis, and monolithic ("box"-like) mountains for epiplatformal.

DOMINANT STRIKE - WITHIN 90° INTERVALS.

NOTE: all divisions and thresholds are indicated as an example; it may be necessary to change them in other regions.

LINEAMENT - A BOUNDARY ZONE BETWEEN AREAS.

RANK = MAXIMAL RANK OF AREAS, WHICH IT SEPARATES.

WIDTH - USUALLY BETWEEN 10 and 40 km, LARGER FOR HIGHER RANKS.

LONGITUDINAL LINEAMENTS - APPROXIMATELY PARALLEL TO DOMINANT STRIKE OF TECTONIC STRUCTURES AND TOPOGRAPHY.

VERTICAL MOVEMENTS ARE CLEARLY EXPRESSED WITHIN.

CONSIDERABLE PART USUALLY INDICATED AS FAULTS ON TECTONIC MAPS.

UNDIRECT EVIDENCES:

CONTACT OF ELEVATIONS AND DEPRESSIONS.

PERIPHERY OF LARGE ELEMENTS OF TOPOGRAPHY

CONTACT OF CONTRAST FORMS OF TOPOGRAPHY - SUCH AS STEEP RIDGE AND FLAT BOTTOM OF A VALLEY, WITHOUT INTERMEDIATE FOREHILLS.

INTENSIVE FAULTING AND FOLDING ALONG THE SAME STRIKE

TRANSVERSE LINEAMENTS

ARE EXPRESSED DISCONTINUOUSLY (EXCEPT SOMETIMES ON COSMIC PHOTOS). NOT ALWAYS ARE SHOWN ON TECTONIC MAPS.

UNDIRECT EVIDENCES:

STRAIGHT VALLEYS

VALLEYS, NOT FOLLOWING THE STEEPEST DESCEND
INTRUSIVE BODIES

SHARP TERMINATION OF LONGITUDINAL STRUCTURES
(GEOLOGICAL OR TOPOGRAPHICAL)

SHARP CHANGE OF THEIR CHARACTERISTICS - AGE, STRIKE,
THICKNESS, ELEVATION ETC

LINEAR OR EN ECHELON PATTERN OF SUCH CHANGES

LINEAR OR EN ECHELON PATTERN OF SPECIFIC FEATURES - VOLCANOES;
PEAKS OR SADDLEPOINTS IN PARALLEL RIDGES ETC

USUALLY, BUT NOT NECESSARILY, FORM A LARGE ANGLE WITH DOMINANT STRIKE OF TECTONICS AND TOPOGRAPHY.

MAJOR STRIKE-SLIP FAULTS - SUCH AS SAN-ANDREAS OR NORTH-ANATOLIAN.

ARE TRACED BY:

OFFSETS OF PERPENDICULAR STRUCTURES - THEY ALWAYS
TERMINATE AT SUCH FAULTS AND NEVER CROSS THEM CONTINUOUSLY
(BY DEFINITION).

GRADUAL ROTATION OF PERPENDICULAR RIDGES, ETC.

KNOTS - SPECIFIC STRUCTURES AROUND INTERSECTION OF LINEAMENTS.

ESPECIALLY INTENSIVE AND CONTRAST MOVEMENTS.

WIDER THAN LINEAMENTS BY ≥ 10 km.

EVIDENCES:

MOSAIC PATTERN OF TOPOGRAPHY;

DIVERSE ELEMENTS OF RELIEF;

BROKEN - LINE FORM OF THEIR BOUNDARIES;

MANY CONTACTS OF CONTRAST ELEMENTS OF RELIEF;

MOSAIC PATTERN OF GEOLOGICAL MAP;

MANY CONTACTS OF ROCKS OF DIFFERENT AGE (E.G. PZ AND Q₂)

A KNOT HAS WELL DEFINED BOUNDARIES. THEIR DETERMINATION REQUIRES
HOWEVER, SPECIAL FIELD STUDIES OR MAYBE DETAILED COSMIC PHOTOS.

Details see M. Alexeevskaya et al, 1977, I Geophysics vol 43

pp 227 - 233

Examples - Gelfand et al, Computational Seismology, NN 6-9, in Russian.

