1	01:00:04:18	01:00:08:00	Annenberg Media
2	01:00:08:02	01:00:11:29	§
3	01:00:12:01	01:00:14:28	MADE POSSIBLE BY SOUTHERN CALIFORNIA CONSORTIUM
4	01:01:01:23	01:01:03:18	*THE GRAND CANYON,*
5	01:01:03:20	01:01:05:14	*1 1/2 KILOMETERS DEEP,*
6	01:01:05:16	01:01:07:14	*AND OVER* *300 KILOMETERS LONG,*
7	01:01:07:16	01:01:08:26	*A GIGANTIC CHASM*
8	01:01:08:28	01:01:11:01	*GOUGED OUT* *OF THE FACE OF THE EARTH*
9	01:01:11:03	01:01:12:16	*BY THE COLORADO RIVER.*
10	01:01:12:18	01:01:15:13	*THIS IS ONE OF THE MOST* *INTRICATE SYSTEMS*
11	01:01:15:15	01:01:18:22	*OF CANYONS, GORGES,* *AND RAVINES IN THE WORLD.*
12	01:01:18:24	01:01:21:11	*THE SPECTACULAR BEAUTY* *OF THIS AWESOME ABYSS*
13	01:01:21:13	01:01:25:27	*DRAWS MILLIONS OF VISITORS* *EACH YEAR.*
14	01:01:25:29	01:01:27:14	*BUT THE GRAND CANYON*
15	01:01:27:16	01:01:30:07	*IS MORE THAN JUST* *A TOURIST ATTRACTION.*
16	01:01:30:09	01:01:32:25	*IT IS A STUNNING MICROCOSM*
17	01:01:32:27	01:01:35:20	*OF THIS PLANET'S* *GEOLOGIC HISTORY.*
18	01:01:37:13	01:01:40:10	THE FIRST GEOLOGIC STUDY OF THE GRAND CANYON
19	01:01:40:12	01:01:44:26	WAS LED BY GEOLOGIST JOHN WESLEY POWELL IN 1869.
20	01:01:44:28	01:01:46:13	POWELL LATER WROTE
21	01:01:46:15	01:01:48:22	THAT ROCKS EXPOSED IN THESE CANYON WALLS
22	01:01:48:24	01:01:51:08	WERE "AN OPEN BOOK OF GEOLOGY."
23	01:01:51:10	01:01:53:27	THE COLORADO RIVER HAD OPENED THE LANDSCAPE,
24	01:01:53:29	01:01:56:28	REVEALING ONE OF THE MOST COMPLETE ROCK RECORDS ON EARTH,
25	01:01:57:00	01:02:00:18	SPANNING ALMOST TWO BILLION YEARS OF EARTH HISTORY.
26	01:02:00:20	01:02:02:09	TO A GEOLOGIST,
27	01:02:02:11	01:02:04:10	A LAYERED SEQUENCE OF SEDIMENTARY ROCKS
28	01:02:04:12	01:02:07:26	IS A HISTORICAL RECORD TO BE READ LIKE A BOOK.
29	01:02:07:28	01:02:10:26	ANALYZING THESE ROCKS FROM THE BASE TO THE TOP,
30	01:02:10:28	01:02:13:24	WE'RE SIFTING THROUGH A WEALTH OF INFORMATION
31	01:02:13:26	01:02:15:24	ABOUT CONDITIONS AT THE EARTH'S SURFACE
32	01:02:15:26	01:02:17:26	WHEN THE SEDIMENTS WERE DEPOSITED.

33 01:02:17:28 01:02:21:06 ROCK CHARACTERISTICS
SUCH AS MINERAL COMPOSITION,
34 01:02:21:08 01:02:22:20 GRAIN SIZE AND SHAPE,
35 01:02:22:22 01:02:25:19 STRUCTURES WITHIN THE ROCK,
AND EVEN ROCK COLOR,
36 01:02:25:21 01:02:28:19 TELL US A GREAT DEAL
ABOUT THE CLIMATE,
37 01:02:28:21 01:02:29:20 VEGETATION PATTERNS,
38 01:02:29:22 01:02:31:09 POSITION
OF THE SHORELINE,
39 01:02:31:11 01:02:34:17 AND THE TOPOGRAPHY
OF THE EARTH'S SURFACE
IN THE GEOLOGIC PAST.
40 01:02:34:19 01:02:36:17 THE CHALLENGE
OF SEDIMENTARY GEOLOGY
41 01:02:36:19 01:02:39:16 IS INTERPRETING THESE CLUES
IN THE ROCKS.
42 01:02:39:18 01:02:42:10 BUT WE MUST FIRST UNDERSTAND
HOW SEDIMENT IS FORMED
43 01:02:42:12 01:02:44:25 AND HOW IT'S TRANSFORMED
INTO SOLID ROCK.
44 01:02:47:18 01:02:49:01 *SEDIMENT IS THE PRODUCT*
45 01:02:49:03 01:02:51:01 *OF MECHANICAL*
AND CHEMICAL WEATHERING,
46 01:02:51:03 01:02:53:22 *AND OF EROSION BY WIND...*
47 01:02:54:26 01:02:56:25 *WATER...*
48 01:02:56:27 01:02:58:26 *AND ICE.*
49 01:02:58:28 01:03:02:10 *BIOLOGICAL ACTIVITY*
ALSO PLAYS A ROLE.
50 01:03:03:28 01:03:05:17 *SEDIMENT MAY BE DEPOSITED*
51 01:03:05:19 01:03:08:28 *IN THE FORM OF SAND*
BUILDING UP AS A DUNE...
52 01:03:09:00 01:03:10:26 *OR A BEACH...*
53 01:03:10:28 01:03:13:26 *AS PEBBLES PILING UP*
IN A STREAM...
54 01:03:13:28 01:03:16:09 *OR SHELLS*
AND ORGANIC MATTER
55 01:03:16:11 01:03:18:19 *ACCUMULATING*
ON THE OCEAN FLOOR.
56 01:03:21:18 01:03:24:16 *WHEN A THICK PILE*
OF SEDIMENT ACCUMULATES,
57 01:03:24:18 01:03:26:26 *THE PARTICLES*
NEAR THE BASE OF THE PILE
58 01:03:26:28 01:03:29:11 *ARE COMPACTED UNDER*
THE OVERLYING DEPOSITS.
59 01:03:29:13 01:03:31:24 *EVENTUALLY,*
THEY ARE CEMENTED TOGETHER
60 01:03:31:26 01:03:34:23 *TO FORM A SOLID*
AGGREGATE ROCK.
61 01:03:37:19 01:03:40:08 *ALTHOUGH 95%*
OF THE EARTH'S CRUST
62 01:03:40:10 01:03:43:07 *IS MADE UP OF IGNEOUS*
OR METAMORPHIC ROCKS,
63 01:03:43:09 01:03:45:22 *THE SURFACE ITSELF*
CONSISTS PRIMARILY
64 01:03:45:24 01:03:48:18 *OF SEDIMENTARY MATERIAL.*

65 01:03:48:20 01:03:50:24 *THE COMPOSITION OF THIS SEDIMENT*

66 01:03:50:26 01:03:53:08 *IS CONTROLLED BY TWO FACTORS--*

67 01:03:53:10 01:03:56:01 *WEATHERING AND EROSION.*

68 01:03:57:04 01:03:58:19 WEATHERING AND EROSION

69 01:03:58:21 01:04:00:19 INFLUENCE THE COMPOSITION OF SEDIMENTARY ROCKS

70 01:04:00:21 01:04:02:07 BECAUSE, FIRST OF ALL,

71 01:04:02:09 01:04:07:07 THE MECHANICAL WEATHERING BREAKS THE ROCKS INTO SMALLER PIECES,

72 01:04:07:09 01:04:09:07 MAKING THEM MORE EASILY ERODED.

73 01:04:09:09 01:04:11:21 CHEMICAL WEATHERING BREAKS DOWN CERTAIN MINERALS

74 01:04:11:23 01:04:13:13 IN PREFERENCE TO OTHERS.

75 01:04:15:23 01:04:18:12 *ONE OF THE MOST COMMON FORMS OF SEDIMENT*

76 01:04:18:14 01:04:20:12 *IS REFERRED TO AS CLASTIC,*

77 01:04:20:14 01:04:22:26 *FROM THE GREEK WORD FOR "BROKEN."*

78 01:04:22:28 01:04:24:26 *FRAGMENTS OF ROCKS AND MINERALS*

79 01:04:24:28 01:04:26:26 *FALLING FROM AN ERODING OUTCROP*

80 01:04:26:28 01:04:30:09 *ARE EXAMPLES OF CLASTIC SEDIMENT.*

81 01:04:30:11 01:04:32:23 *CLASTIC SEDIMENTS ARE CLASSIFIED BY SIZE,*

82 01:04:32:25 01:04:36:09 *RANGING FROM LARGE BOULDERS*

83 01:04:36:11 01:04:39:29 *THROUGH SMALLER COBBLES AND PEBBLES...*

84 01:04:40:01 01:04:42:07 *THEN GRAINS OF SAND...*

85 01:04:42:09 01:04:45:20 *EVEN SMALLER GRAINS OF SILT...*

86 01:04:45:22 01:04:49:21 *AND FINALLY DOWN TO THE FINEST SEDIMENT OF ALL--*

87 01:04:49:23 01:04:53:05 *CLAY--WHICH HAS THE CONSISTENCY OF FLOUR.*

88 01:04:56:09 01:04:59:07 *SEDIMENT CAN BE TRANSPORTED IN VARIOUS WAYS.*

89 01:04:59:09 01:05:01:29 *IT CAN SLIDE DOWN A HILLSIDE,*

90 01:05:02:01 01:05:04:29 *BE BLOWN BY THE WIND,*

91 01:05:05:01 01:05:08:21 *OR BE CARRIED ALONG BY A FLOWING STREAM.*

92 01:05:10:24 01:05:12:19 *AS SEDIMENT IS TRANSPORTED,*

93 01:05:12:21 01:05:15:20 *IT TENDS TO BE SMOOTHED AND ROUNDED*

94 01:05:15:22 01:05:18:22 *AS FRAGMENTS HIT AND SCRAPE AGAINST ONE ANOTHER.*

95 01:05:21:06 01:05:22:19 *SORTING IS CONTROLLED*

96 01:05:22:21 01:05:24:18 *BY THE SIZE AND WEIGHT OF PARTICLES,*
97 01:05:24:20 01:05:27:18 *WITH THE HEAVIEST SEDIMENT BEING DEPOSITED FIRST,*
98 01:05:27:20 01:05:31:17 *AND FINER SEDIMENT TRANSPORTED CONSIDERABLE DISTANCES.*
99 01:05:33:21 01:05:35:20 [DEE TRENT] A DEPOSITION TYPICALLY OCCURS
100 01:05:35:22 01:05:38:10 WHEREVER THERE'S A SLOWING OF THE RUNNING WATER.
101 01:05:38:12 01:05:40:03 A GOOD EXAMPLE WOULD BE
102 01:05:40:05 01:05:42:18 AT THE BASE OF A STEEP MOUNTAIN RANGE,
103 01:05:42:20 01:05:45:19 WHERE THE RIVERS ARE COMING OUT OF A STEEP CANYON
104 01:05:45:21 01:05:47:02 INTO A FLAT VALLEY.
105 01:05:47:04 01:05:49:20 THE KINDS OF MATERIALS THAT WOULD BE FORMED THERE
106 01:05:49:22 01:05:51:04 WOULD BE VERY COARSE GRAINED.
107 01:05:51:06 01:05:52:19 THE FURTHER AWAY YOU GET
108 01:05:52:21 01:05:54:19 FROM THE FRONT OF THE MOUNTAIN RANGE,
109 01:05:54:21 01:05:57:03 THE FINER THE GRAIN IS OF THE SEDIMENT BEING CARRIED.
110 01:05:57:05 01:05:58:18 CONSEQUENTLY, YOU WOULD GET
111 01:05:58:20 01:06:01:08 FINER GRAINED SANDSTONES OR SILTSTONES FURTHER AWAY.
112 01:06:01:10 01:06:03:28 THE SAME THING HAPPENS IN AN OCEAN,
113 01:06:04:00 01:06:06:12 WHERE A RIVER ENTERS THE OCEAN.
114 01:06:06:14 01:06:08:11 THE FIRST THINGS THAT DROP OUT
115 01:06:08:13 01:06:09:26 ARE THE COARSE GRAIN MATERIALS,
116 01:06:09:28 01:06:11:10 GENERALLY SAND-SIZED MATERIALS.
117 01:06:11:12 01:06:12:18 FURTHER OUT TO SEA
118 01:06:12:20 01:06:14:17 THERE WILL BE FINE GRAIN MATERIALS.
119 01:06:14:19 01:06:17:16 THE SANDS ARE USUALLY FOUND ON THE COASTS,
120 01:06:17:18 01:06:21:01 WHERE THE MUDS AND CLAYS WOULD BE FURTHER OFFSHORE.
121 01:06:23:03 01:06:24:25 *THE PROCESS WHICH CONVERTS*
122 01:06:24:27 01:06:28:03 *LOOSE CLASTIC SEDIMENT INTO SOLID SEDIMENTARY ROCK*
123 01:06:28:05 01:06:31:17 *IS KNOWN AS LITHIFICATION,*
124 01:06:31:19 01:06:34:16 *FROM THE GREEK* LITHOS, *MEANING "STONE."*
125 01:06:36:19 01:06:40:12 THE FIRST MECHANISM IS ONE OF SIMPLE COMPACTION.

126 01:06:40:14 01:06:42:27 THE WEIGHT OF
THE OVERLYING SEDIMENTS
127 01:06:42:29 01:06:45:12 SQUEEZING DOWN,
GRAIN BY GRAIN,
128 01:06:45:14 01:06:48:11 CAUSING THE GRAINS
TO ULTIMATELY REARRANGE
129 01:06:48:13 01:06:51:01 SO THAT THEY GET
INTO CLOSE PACKING
130 01:06:51:03 01:06:52:17 AND FINALLY DISTORTION
131 01:06:52:19 01:06:54:26 AND PERHAPS SOLUTION
OF THE GRAINS
132 01:06:54:28 01:06:56:20 SO THAT, ULTIMATELY,
133 01:06:56:22 01:07:03:01 YOU HAVE A VERY TIGHTLY
PACKED ASSEMBLAGE
OF SEDIMENTARY GRAINS.
134 01:07:03:03 01:07:04:26 AT THE SAME TIME,
135 01:07:04:28 01:07:09:01 THERE MAY VERY WELL BE
CHEMICAL PRECIPITATION
WITHIN THE PORE SPACE,
136 01:07:09:03 01:07:12:20 AND THAT'S CALLED--
THERE'S TWO TERMS
THAT ARE USED HERE,
137 01:07:12:22 01:07:15:26 BUT THE BEST TERM
FOR THAT IS CEMENTATION.
138 01:07:15:28 01:07:20:01 THESE TWO PROCESSES
ACTING IN CONCERT
139 01:07:20:03 01:07:23:29 GO TO MAKE
A LOOSE SEDIMENT
INTO A HARD ROCK.
140 01:07:26:28 01:07:29:00 *IN CONTRAST*
TO LITHIFICATION,
141 01:07:29:02 01:07:31:10 *SEDIMENTARY ROCKS*
MAY ALSO FORM
142 01:07:31:12 01:07:34:29 *FROM THE PRECIPITATION*
OF CHEMICALS OUT OF WATER.
143 01:07:35:01 01:07:38:00 *ONE COMMON SITE*
OF CHEMICAL SEDIMENTATION
144 01:07:38:02 01:07:40:15 *IS DESERT LAKES*
AND LAGOONS.
145 01:07:40:17 01:07:43:00 *AS EVAPORATION OCCURS,*
146 01:07:43:02 01:07:44:15 *THE CHEMICALS*
BECOME INCREASINGLY
147 01:07:44:17 01:07:46:11 *CONCENTRATED IN THE WATER*
148 01:07:46:13 01:07:50:05 *UNTIL THEY CAN NO LONGER*
REMAIN DISSOLVED.
149 01:07:50:07 01:07:51:24 *THEY COMBINE*
WITH ONE ANOTHER,
150 01:07:51:26 01:07:55:10 *FORMING MINERALS SUCH AS*
CALCITE, GYPSUM, AND SALT.
151 01:07:57:07 01:08:00:10 *DEPOSITS FORMED FROM*
EVAPORATION ARE CALLED
152 01:08:00:12 01:08:01:18 *EVAPORITES.*
153 01:08:06:15 01:08:10:23 *CHEMICAL SEDIMENTATION ALSO*
TAKES PLACE IN THE OCEAN.
154 01:08:10:25 01:08:13:13 *BIOLOGICAL PROCESSES*
PLAY A CRUCIAL ROLE

155 01:08:13:15 01:08:15:23 *IN TRIGGERING*
THIS PHENOMENON.
156 01:08:15:25 01:08:18:13 *ALGAE, CORAL,*
AND INVERTEBRATE ORGANISMS
157 01:08:18:15 01:08:20:18 *ALL UTILIZE*
CALCIUM CARBONATE
158 01:08:20:20 01:08:23:02 *IN CONSTRUCTING*
SHELLS AND REEFS.
159 01:08:26:10 01:08:28:03 *WHEN THESE ORGANISMS DIE,*
160 01:08:28:05 01:08:31:12 *THEIR CARBONATE HARD PARTS*
ACCUMULATE ON THE SEA FLOOR
161 01:08:31:14 01:08:33:00 *TO FORM LIMESTONE,*
162 01:08:33:02 01:08:36:18 *ONE OF THE MOST COMMON*
SEDIMENTARY ROCKS ON EARTH.
163 01:08:36:20 01:08:39:15 *LIMESTONES VARY GREATLY*
IN APPEARANCE,
164 01:08:39:17 01:08:42:25 *FROM FORMATIONS PACKED*
WITH LARGE FOSSILS
165 01:08:42:27 01:08:45:03 *TO BEDS OF CHALK FORMED*
166 01:08:45:05 01:08:48:07 *FROM THE MICROSCOPIC SHELLS*
OF PLANTS AND ANIMALS.
167 01:08:52:00 01:08:54:03 *LIFE ALSO CONTRIBUTES*
TO THE FORMATION
168 01:08:54:05 01:08:57:03 *OF SEDIMENTARY ROCKS*
OTHER THAN LIMESTONE.
169 01:08:57:05 01:08:59:03 *IN THE COOL,*
NUTRIENT-RICH WATER
170 01:08:59:05 01:09:01:06 *NEAR SOME*
CONTINENTAL SHELVES,
171 01:09:01:08 01:09:04:12 *RADIOLARIA AND DIATOMS*
THRIVE.
172 01:09:04:14 01:09:07:02 *THESE SUSPENDED*
MICROSCOPIC ORGANISMS
173 01:09:07:04 01:09:10:11 *USE SILICA*
TO MAKE THEIR SHELLS.
174 01:09:10:13 01:09:13:06 *WHEN THEY DIE AND SETTLE*
TO THE SEA FLOOR,
175 01:09:13:08 01:09:14:17 *THE SILICA ACCUMULATES*
176 01:09:14:19 01:09:17:15 *TO FORM LAYERS*
OF CHERT AND DIATOMITE.
177 01:09:20:13 01:09:23:18 *IN SWAMPY BAYOUS*
AND DELTAS ON SHORE,
178 01:09:23:20 01:09:25:21 *THE REMAINS OF MOSS,*
LEAVES, ROOTS,
179 01:09:25:23 01:09:27:08 *AND TREE TRUNKS*
180 01:09:27:10 01:09:30:22 *MAY GRADUALLY COMPACT*
OVER MILLIONS OF YEARS,
181 01:09:30:24 01:09:34:07 *GIVING RISE TO ANOTHER*
SEDIMENTARY ROCK--
182 01:09:34:09 01:09:35:11 *COAL.*
183 01:09:36:24 01:09:42:22 COAL IS FORMED IN AREAS
OF SWAMPS, QUIET WATER,
184 01:09:42:24 01:09:46:18 LIKE OKEFENOKEE SWAMP
AND AREAS IN SOUTHEAST ASIA
185 01:09:46:20 01:09:49:03 WHERE YOU HAVE
LOTS OF VEGETATION

186 01:09:49:05 01:09:52:05 IN SHALLOW WATER
OVER MILLIONS OF YEARS
187 01:09:52:07 01:09:55:02 AND MATERIAL GROWS, DIES,
SETTLES DOWN.
188 01:09:55:04 01:09:57:16 DUE TO THE CHEMISTRY
OF THE WATER,
189 01:09:57:18 01:10:00:03 THE MATERIAL
DOES NOT ROT AWAY.
190 01:10:00:05 01:10:02:00 LAYER AFTER LAYER
BUILDS UP
191 01:10:02:02 01:10:03:23 AND WITH TIME,
SUFFICIENT PRESSURE,
192 01:10:03:25 01:10:05:12 IT'S CONVERTED
FIRST TO PEAT
193 01:10:05:14 01:10:07:03 AND EVENTUALLY TO COAL.
194 01:10:10:13 01:10:12:16 *THE PLACES WHERE*
SEDIMENT IS DEPOSITED
195 01:10:12:18 01:10:13:26 *VARY ENORMOUSLY,*
196 01:10:13:28 01:10:16:16 *FROM GLACIAL VALLEYS...*
197 01:10:16:18 01:10:18:16 *LAKES...*
198 01:10:18:18 01:10:20:15 *BEACHES...*
199 01:10:20:17 01:10:23:04 *RIVER DELTAS...*
200 01:10:23:06 01:10:25:05 *TO THE SEA FLOOR.*
201 01:10:26:28 01:10:29:06 *THESE ENVIRONMENTS*
OF DEPOSITION
202 01:10:29:08 01:10:32:01 *ARE NEARLY ALWAYS INITIALLY*
ASSOCIATED WITH WATER,
203 01:10:32:03 01:10:35:06 *BUT MAY EVENTUALLY*
TRANSFORM INTO DRY LAND.
204 01:10:39:29 01:10:43:17 GEOLOGISTS INTERPRET
THE CHARACTERISTICS
OF SEDIMENTARY ROCKS
205 01:10:43:19 01:10:45:26 USING THE PRINCIPLE
OF UNIFORMITY.
206 01:10:45:28 01:10:47:16 THIS PRINCIPLE IS A MODEL
207 01:10:47:18 01:10:49:21 OF THE WAY
SEDIMENTARY ROCKS FORM.
208 01:10:49:23 01:10:51:07 ACCORDING TO THIS MODEL,
209 01:10:51:09 01:10:53:01 WE ACCEPT THAT
SEDIMENTARY ROCKS
210 01:10:53:03 01:10:55:05 HAVE FORMED THROUGHOUT
GEOLOGIC TIME
211 01:10:55:07 01:10:59:05 IN EXACTLY THE SAME WAY THAT
SEDIMENTS ARE FORMING TODAY.
212 01:10:59:07 01:11:02:24 THROUGHOUT EARTH HISTORY
THE SAME GEOLOGIC PROCESSES,
213 01:11:02:26 01:11:04:08 SUCH AS WEATHERING,
214 01:11:04:10 01:11:05:18 RUNNING WATER,
215 01:11:05:20 01:11:07:09 WIND, TIDES,
216 01:11:07:11 01:11:08:29 CHANGING SEA LEVEL,
217 01:11:09:01 01:11:11:14 HAVE CREATED
AND DEPOSITED SEDIMENTS
218 01:11:11:16 01:11:14:14 THAT EVENTUALLY WERE
HARDENED INTO ROCK.
219 01:11:14:16 01:11:15:29 THE PRINCIPLE OF UNIFORMITY
220 01:11:16:01 01:11:19:09 SAYS THAT THE PRESENT

IS THE KEY TO THE PAST,

221 01:11:19:11 01:11:22:09 SO AS WE STUDY SEDIMENTS
BEING DEPOSITED RIGHT NOW

222 01:11:22:11 01:11:24:20 AND ASSOCIATE
THEIR CHARACTERISTICS

223 01:11:24:22 01:11:27:04 WITH THE CONDITIONS
AT THE EARTH'S SURFACE,

224 01:11:27:06 01:11:28:20 WE ARE CREATING MODELS

225 01:11:28:22 01:11:31:11 FOR INTERPRETING ENVIRONMENTS
IN THE GEOLOGIC PAST.

226 01:11:31:13 01:11:33:26 THIS PRINCIPLE
CAN BE VERY EASY TO USE.

227 01:11:33:28 01:11:35:12 THIS LIMESTONE, FOR EXAMPLE,

228 01:11:35:14 01:11:38:13 IS MADE OF GRAY
CALCIUM CARBONATE MUD,

229 01:11:38:15 01:11:39:28 A LITTLE QUARTZ SAND,

230 01:11:40:00 01:11:42:13 AND THE FOSSILS
OF MARINE ORGANISMS.

231 01:11:42:15 01:11:45:12 SEDIMENT BEING DEPOSITED
IN SHALLOW TROPICAL SEAS,

232 01:11:45:14 01:11:47:29 SUCH AS THE BAHAMAS
AND THE FLORIDA KEYS,

233 01:11:48:01 01:11:50:15 WOULD LOOK VERY MUCH
LIKE THIS LIMESTONE

234 01:11:50:17 01:11:52:15 IF THEY WERE
HARDENED INTO ROCK,

235 01:11:52:17 01:11:55:00 SO IN THIS CASE
UNIFORMITY IS TELLING US

236 01:11:55:02 01:11:58:08 THAT THIS AREA WAS COVERED
BY A SHALLOW TROPICAL SEA

237 01:11:58:10 01:12:00:12 ABOUT 250 MILLION YEARS AGO.

238 01:12:00:14 01:12:03:11 WHEN GEOLOGISTS USE
THE PRINCIPLE OF UNIFORMITY

239 01:12:03:13 01:12:06:02 TO ANALYZE AN ENTIRE SEQUENCE
OF SEDIMENTARY ROCKS,

240 01:12:06:04 01:12:09:01 THE CHANGING ENVIRONMENTS
RECORDED IN THAT SEQUENCE

241 01:12:09:03 01:12:11:22 SHOWS US HOW
THE EARTH'S SURFACE ITSELF

242 01:12:11:24 01:12:13:27 CHANGED AND EVOLVED
THROUGH TIME.

243 01:12:16:24 01:12:19:06 *THE DEPOSITION*
OF SEDIMENT IS RECORDED

244 01:12:19:08 01:12:22:06 *IN THE ROCK RECORD*
AS SEDIMENTARY STRUCTURES.

245 01:12:23:24 01:12:27:16 [WALTER REED]
SEDIMENTARY STRUCTURES
ARE USEFUL TO US

246 01:12:27:18 01:12:30:01 BECAUSE THEY CAN
ALLOW US TO RECONSTRUCT

247 01:12:30:03 01:12:33:00 THE ENVIRONMENTS
OF DEPOSITION
OF THE SEDIMENTS.

248 01:12:33:02 01:12:36:27 THAT'S WHERE THE SEDIMENTARY
STRUCTURES ARE FORMED.

249 01:12:36:29 01:12:39:01 THEY'RE NOT FORMED

DURING EROSION,
250 01:12:39:03 01:12:41:01 THEY'RE NOT FORMED
DURING TRANSPORTATION,
251 01:12:41:03 01:12:43:17 BUT DURING DEPOSITION,
252 01:12:43:19 01:12:45:04 SO THE SEDIMENTARY
STRUCTURES--
253 01:12:45:06 01:12:48:04 AND THERE'S A VERY WIDE
VARIETY OF THEM--
254 01:12:48:06 01:12:52:13 ARE INDICATIVE
OF A GIVEN SITE
OF DEPOSITION.
255 01:12:52:15 01:12:55:07 *ONE OF THE MOST OBVIOUS*
OF THESE STRUCTURES
256 01:12:55:09 01:12:56:23 *IS BEDDING--*
257 01:12:56:25 01:13:00:09 *THE LAYER CAKE PATTERN*
OF ROCK STRATA.
258 01:13:00:11 01:13:02:22 *THE CONTACT BETWEEN*
TWO LAYERS OF ROCK
259 01:13:02:24 01:13:05:11 *IS CALLED*
A BEDDING PLANE.
260 01:13:05:13 01:13:07:26 [REED] ONE OF
THE VERY DISTINCTIVE,
261 01:13:07:28 01:13:10:24 AND PROBABLY
THE MOST COMPELLING
SEDIMENTARY STRUCTURE
262 01:13:10:26 01:13:16:00 THAT ONE SEES WHEN ONE
LOOKS AT A STACK
OF SEDIMENTS, IS BEDS.
263 01:13:16:02 01:13:20:00 BEDDING SURFACES
REPRESENT INTERRUPTIONS.
264 01:13:20:02 01:13:22:00 THEY MAY BE
LONG INTERRUPTIONS
265 01:13:22:02 01:13:23:14 OR SHORT INTERRUPTIONS.
266 01:13:23:16 01:13:26:05 THEY MAY BE JUST
PULSES OF SEDIMENT
267 01:13:26:07 01:13:28:05 WHERE AN INTERRUPTION
LASTS--
268 01:13:28:07 01:13:30:21 JUST A MOMENTARY
INTERRUPTION.
269 01:13:30:23 01:13:32:05 THEY MAY BE
INTERRUPTIONS
270 01:13:32:07 01:13:35:12 OF THOUSANDS OR EVEN
MILLIONS OF YEARS.
271 01:13:35:14 01:13:40:10 WHAT IS VERY OBVIOUS
FROM EVERYTHING
WE KNOW NOW
272 01:13:40:12 01:13:44:08 IS THAT THE SEDIMENTARY
COLUMN THAT WE HAVE,
273 01:13:44:10 01:13:46:21 THE BEDDING SURFACES
THEMSELVES,
274 01:13:46:23 01:13:51:20 ALMOST CERTAINLY
REPRESENT FAR MORE TIME
275 01:13:51:22 01:13:54:24 THAN THE STACK
OF SEDIMENTS THAT
WE HAVE PRESERVED.
276 01:13:57:01 01:13:59:01 *THE LAW OF*

ORIGINAL HORIZONTALITY

277 01:13:59:03 01:14:01:14 *STATES THAT MOST BEDDING*
INITIALLY FORMS

278 01:14:01:16 01:14:03:14 *IN A HORIZONTAL*
ORIENTATION,

279 01:14:03:16 01:14:06:04 *AS MATERIAL SETTLES*
TO A LAKE BED

280 01:14:06:06 01:14:07:17 *OR THE SEA FLOOR.*

281 01:14:09:20 01:14:12:03 *BUT IN SOME CASES,*
SLOPING LAYERS

282 01:14:12:05 01:14:14:13 *OF SEDIMENTARY ROCK*
BUILD UP.

283 01:14:14:15 01:14:18:08 *FOR EXAMPLE, WIND CAN*
PILE UP SAND AS DUNES.

284 01:14:19:25 01:14:21:04 *AS MINERAL GRAINS*

285 01:14:21:06 01:14:23:04 *OF DIVERSE COLOR*
AND COMPOSITION

286 01:14:23:06 01:14:24:23 *ARE BLOWN*
ACROSS THE DUNE,

287 01:14:24:25 01:14:26:28 *DISCERNIBLE LAYERING*
CAN DEVELOP

288 01:14:27:00 01:14:31:02 *INCLINED AT AN ANGLE PARALLEL*
TO THE SLOPE OF THE DUNE.

289 01:14:34:04 01:14:35:18 *SUCH ANGLED LAYERS*

290 01:14:35:20 01:14:39:18 *ALSO DEVELOP IN SAND BARS*
AND STREAM DELTAS.

291 01:14:39:20 01:14:42:12 *GEOLOGISTS REFER TO THIS*
AS CROSS-BEDDING

292 01:14:42:14 01:14:43:28 *BECAUSE IT CUTS ACROSS*

293 01:14:44:00 01:14:46:17 *THE DIRECTION OF ORDINARY*
HORIZONTAL BEDDING.

294 01:14:47:26 01:14:50:29 *SETS OF CROSS-BEDS*
OFTEN DEVELOP.

295 01:14:51:01 01:14:53:28 *FOR EXAMPLE, AT ANY*
GIVEN POINT IN A STREAM,

296 01:14:54:00 01:14:55:11 *PERIODS OF DEPOSITION*

297 01:14:55:13 01:14:58:07 *MAY ALTERNATE*
WITH PERIODS OF EROSION

298 01:14:58:09 01:15:02:17 *AS THE VELOCITY OF*
THE WIND OR WATER CHANGES.

299 01:15:02:19 01:15:05:16 *A SET OF CROSS-BEDS*
IN A BAR

300 01:15:05:18 01:15:08:16 *WILL BE TRUNCATED*
BY EROSION...

301 01:15:08:18 01:15:11:15 *THEN COVERED BY*
ANOTHER SET OF CROSS-BEDS

302 01:15:11:17 01:15:13:11 *WHEN DEPOSITION RESUMES.*

303 01:15:14:21 01:15:18:02 CROSS-BEDDING IS
A SEDIMENTARY STRUCTURE

304 01:15:18:04 01:15:20:08 THAT IS VERY REVEALING.

305 01:15:20:10 01:15:24:21 IF WE LOOK AT
A SET OF CROSS-BEDS
THAT ARE VERY STEEP,

306 01:15:24:23 01:15:28:19 THAT ARE TRUNCATED
BY THE NEXT SET
OF CROSS-BEDS,

307 01:15:28:21 01:15:31:21 THEN WE KNOW THAT
WE HAD A RIVER SYSTEM
308 01:15:31:23 01:15:33:14 OR A DEPOSITIONAL SYSTEM
309 01:15:33:16 01:15:36:21 THAT WAS CONSTANTLY
INTERRUPTING ITSELF
AND SHIFTING AROUND.
310 01:15:36:23 01:15:39:22 IF WE HAVE
A SMOOTH PROGRADATION
OF CROSS-BEDS,
311 01:15:39:24 01:15:41:10 WE KNOW THERE'S
NO INTERRUPTION
312 01:15:41:12 01:15:44:12 AND IT'S JUST A STEADY
STREAM OF DEPOSITION
313 01:15:44:14 01:15:47:13 IN MORE OR LESS
A CONSTANT FASHION.
314 01:15:49:18 01:15:51:16 *GEOLOGISTS*
FIND CROSS-BEDS USEFUL
315 01:15:51:18 01:15:54:16 *IN DETERMINING THE DIRECTION*
OF SEDIMENT TRANSPORT
316 01:15:54:18 01:15:57:06 *IN ANCIENT RIVER*
AND DUNE SYSTEMS.
317 01:15:58:17 01:16:00:13 *CROSS-BEDS*
FORM PERPENDICULAR
318 01:16:00:15 01:16:02:28 *TO THE DIRECTION*
OF THE WATER CURRENT
319 01:16:03:00 01:16:05:09 *AND TEND*
TO SLOPE DOWNSTREAM.
320 01:16:07:00 01:16:09:08 IF YOU'VE EVER
LOOKED AT A RIVER
321 01:16:09:10 01:16:10:26 IN ANY KIND OF DETAIL,
322 01:16:10:28 01:16:14:00 YOU KNOW THAT
A RIVER DOESN'T RUN
IN STRAIGHT LINE.
323 01:16:14:02 01:16:15:15 IT MEANDERS AROUND.
324 01:16:15:17 01:16:18:15 SO IF WE GET MANY
CROSS-BED MEASUREMENTS,
325 01:16:18:17 01:16:22:01 THEN WE CAN COME UP WITH
A STATISTICAL AVERAGE
326 01:16:22:03 01:16:25:08 FOR THE DIRECTION
THE RIVER WAS FLOWING.
327 01:16:25:10 01:16:28:00 IF WE GO DOWNSTREAM,
328 01:16:28:02 01:16:31:14 DOWN THAT RIVER
WE'LL FIND THAT SORTING
BECOMES BETTER,
329 01:16:31:16 01:16:34:04 SEDIMENT SIZE TENDS
TO BECOME LESS,
330 01:16:34:06 01:16:35:13 AND SO FORTH.
331 01:16:37:15 01:16:40:00 *ANOTHER COMMON*
SEDIMENTARY STRUCTURE,
332 01:16:40:02 01:16:41:15 *RIPPLE MARKS,*
333 01:16:41:17 01:16:44:00 *OFTEN DEVELOPS*
IN SOFT BEDS OF SAND
334 01:16:44:02 01:16:45:23 *LYING IN SHALLOW WATER.*
335 01:16:48:01 01:16:50:14 *THE TO-AND-FRO*
MOTION OF WAVES
336 01:16:50:16 01:16:52:06 *CREATES*

SYMMETRICAL RIPPLES.

337 01:16:53:23 01:16:57:03 *WHEN THEY'RE SCULPTED BY*
THE ONE-WAY MOTION OF CURRENTS,

338 01:16:57:05 01:17:00:05 *THEY ARE ASYMMETRIC,*
WITH THEIR STEEPER SIDES

339 01:17:00:07 01:17:02:06 *FACING IN*
THE DOWN-CURRENT DIRECTION.

340 01:17:05:14 01:17:08:03 *SOMETIMES THE SURFACE OF*
A FINE SEDIMENTARY BED

341 01:17:08:05 01:17:09:17 *IS ALSO BROKEN UP*

342 01:17:09:19 01:17:12:12 *INTO A PAVEMENT*
OF FOSSIL MUD CRACKS,

343 01:17:12:14 01:17:14:17 *EITHER WITH*
THE FISSURE STILL OPEN

344 01:17:14:19 01:17:16:17 *OR WITH*
THE GAPS FILLED IN

345 01:17:16:19 01:17:18:28 *BY LATER DEPOSITS*
OF SEDIMENT.

346 01:17:19:00 01:17:23:11 [REED] MUD CRACKS
ARE A VERY GOOD
INDICATOR

347 01:17:23:13 01:17:25:01 OF ENVIRONMENTS.

348 01:17:25:03 01:17:29:01 WE'VE ALL BEEN
IN RIVER BEDS
OR IN TIDAL FLATS

349 01:17:29:03 01:17:31:00 IN WHICH WE'VE SEEN
DESICCATION

350 01:17:31:02 01:17:33:00 AND FORMATION
OF MUD CRACKS.

351 01:17:33:02 01:17:36:12 THESE ARE PRESERVED
IN THE GEOLOGIC RECORD.

352 01:17:36:14 01:17:38:11 IF A SAND, UH, IS--

353 01:17:38:13 01:17:41:10 IF SAND IS WASHED OVER
THAT MUD CRACK,

354 01:17:41:12 01:17:44:15 IT INFILTRATES DOWN INTO
THE END OF THE CRACK

355 01:17:44:17 01:17:46:00 AND PRESERVES THE CRACK.

356 01:17:46:02 01:17:48:29 WE CAN IDENTIFY THEM
IN RIVER DEPOSITS.

357 01:17:49:01 01:17:50:28 THEY SHOW UP
ON NATURAL LEVEES.

358 01:17:51:00 01:17:53:27 THEY SHOW UP
ON FLOOD PLAINS
AND SO FORTH.

359 01:17:53:29 01:17:55:27 THEY SHOW UP
IN MEANDERING,

360 01:17:55:29 01:17:57:27 AS WELL
AS BRAIDED STREAMS.

361 01:17:57:29 01:18:00:10 THEY SHOW UP
IN DELTAIC DEPOSITS

362 01:18:00:12 01:18:03:10 WHERE A GIVEN
DELTA DISTRIBUTARY

363 01:18:03:12 01:18:06:11 IS STRANDED
OR ABANDONED.

364 01:18:06:13 01:18:09:25 AND SO THEY CAN BE
VERY USEFUL TO US

365 01:18:09:27 01:18:12:25 BECAUSE THEY TELL US
THAT THE SITUATION
366 01:18:12:27 01:18:14:25 AT THE TIME
OF SEDIMENTATION
367 01:18:14:27 01:18:17:29 WAS SUCH
THAT IT BECAME DRY.
368 01:18:19:27 01:18:23:16 *BY UNDERSTANDING*
HOW MUD CRACKS,
RIPPLE MARKS,
369 01:18:23:18 01:18:25:04 *CROSS-BEDDING,*
370 01:18:25:06 01:18:27:26 *AND OTHER SEDIMENTARY*
STRUCTURES AND TEXTURES FORM,
371 01:18:27:28 01:18:29:25 *GEOLOGISTS CAN,*
IN A SENSE,
372 01:18:29:27 01:18:33:11 *READ THE SEDIMENTARY*
ROCK RECORD.
373 01:18:33:13 01:18:35:10 *THIS ALLOWS THEM*
TO RECONSTRUCT
374 01:18:35:12 01:18:38:24 *THE PHYSICAL APPEARANCE*
OF ANCIENT LANDSCAPES.
375 01:18:40:28 01:18:42:26 *ONE PLACE SUCH WORK*
IS BEING DONE
376 01:18:42:28 01:18:45:10 *IS KNOWN AS*
THE RIDGE BASIN,
377 01:18:45:12 01:18:48:10 *A THICK SEQUENCE*
OF SEDIMENTARY ROCKS
378 01:18:48:12 01:18:50:10 *SANDWICHED BETWEEN*
THE SAN ANDREAS
379 01:18:50:12 01:18:53:27 *AND THE SAN GABRIEL FAULTS*
IN SOUTHERN CALIFORNIA.
380 01:18:53:29 01:18:57:11 *TODAY, THIS AREA IS NOT*
A BASIN AT ALL.
381 01:18:57:13 01:18:59:24 *IT IS INSTEAD*
PART OF A YOUNG,
382 01:18:59:26 01:19:01:18 *GROWING MOUNTAIN RANGE.*
383 01:19:01:20 01:19:04:08 *YET 5 TO 10*
MILLION YEARS AGO,
384 01:19:04:10 01:19:06:16 *IT WAS*
A DEEP DEPRESSION.
385 01:19:06:18 01:19:09:23 *TO DETERMINE HOW*
THE RIDGE BASIN FORMED
386 01:19:09:25 01:19:12:08 *SEDIMENTOLOGISTS LIKE*
CATHY BUSBY-SPERA
387 01:19:12:10 01:19:15:09 *ATTEMPT TO FIND OUT*
WHAT THE RIDGE BASIN
388 01:19:15:11 01:19:16:24 *ONCE LOOKED LIKE.*
389 01:19:16:26 01:19:20:08 HERE WE'RE LOOKING AT
A VERY THICK SUCCESSION
390 01:19:20:10 01:19:21:23 OF FINE-GRAIN DEPOSITS
391 01:19:21:25 01:19:25:17 THAT WE CAN INTERPRET
AS LAKE DEPOSITS.
392 01:19:25:19 01:19:28:03 THERE ARE SEVERAL
LINES OF EVIDENCE
393 01:19:28:05 01:19:30:17 THAT WE CAN USE
TO DETERMINE
394 01:19:30:19 01:19:32:19 THIS WAS DEPOSITED

IN A LAKE.

395 01:19:32:21 01:19:35:19 FIRST OF ALL,
THE FINE GRAIN SIZE

396 01:19:35:21 01:19:38:04 AND THE THINNESS
OF THE BEDS

397 01:19:38:06 01:19:41:05 INDICATES
SLOW DEPOSITION
BY FINE-GRAIN SEDIMENT

398 01:19:41:07 01:19:43:23 SETTLING THROUGH
A WATER COLUMN.

399 01:19:43:25 01:19:45:23 ANOTHER THING
IS THAT THE BEDS

400 01:19:45:25 01:19:47:07 ARE VERY LATERALLY
CONTINUOUS,

401 01:19:47:09 01:19:49:17 AS YOU CAN SEE
IN THIS OUTCROP,

402 01:19:49:19 01:19:52:08 WHICH WOULD
SUGGEST DEPOSITION
IN A BIG FEATURE

403 01:19:52:10 01:19:55:08 LIKE A LAKE RATHER
THAN A SMALL FEATURE

404 01:19:55:10 01:19:57:12 LIKE A RIVER CHANNEL.

405 01:19:57:14 01:20:01:12 THE THIRD THING
THAT WE CAN'T REALLY
SEE FROM HERE

406 01:20:01:14 01:20:04:10 IS THAT SOME
OF THE THINNER BEDS

407 01:20:04:12 01:20:06:11 IN THIS SUCCESSION
ARE LIMESTONES

408 01:20:06:13 01:20:08:11 AND THEY BEAR
MICRO FOSSILS

409 01:20:08:13 01:20:10:24 THAT INDICATE
DEPOSITION
IN FRESH WATER.

410 01:20:10:26 01:20:14:09 ANOTHER FEATURE
WE CAN USE
TO IDENTIFY A LAKE

411 01:20:14:11 01:20:17:15 IS MUD CRACKS

412 01:20:17:17 01:20:20:10 AND WAVE RIPPLES.

413 01:20:20:12 01:20:23:24 THESE FEATURES
ALL TAKEN TOGETHER--

414 01:20:23:26 01:20:25:29 THE WAVE RIPPLES,
THE MUD CRACKS,

415 01:20:26:01 01:20:27:13 THE FRESH-WATER
FOSSILS,

416 01:20:27:15 01:20:30:13 AND THE FINE-GRAIN
NATURE OF THE DEPOSIT,

417 01:20:30:15 01:20:32:13 GIVE US REAL
CONVINCING ARGUMENTS

418 01:20:32:15 01:20:35:05 THAT THIS
IS A LAKE SETTING.

419 01:20:36:18 01:20:39:11 *IN PLACES, THE EDGES*
OF THE ANCIENT LAKE

420 01:20:39:13 01:20:41:26 *CAN BE SEEN*
IN THE ROCKS.

421 01:20:41:28 01:20:44:27 *THE RIVERS WHICH ONCE*

POURED INTO THIS LAKE

422 01:20:44:29 01:20:47:27 *HAVE ALSO LEFT EVIDENCE OF THEIR PREVIOUS EXISTENCE.*

423 01:20:47:29 01:20:50:26 THIS LAKE WAS THE SITE OF DEPOSITION

424 01:20:50:28 01:20:54:17 OF FINE-GRAIN SEDIMENTS OR MUDS,

425 01:20:54:19 01:20:57:08 BUT PERIODICALLY, RIVERS BUILT INTO THIS LAKE.

426 01:20:57:10 01:20:59:07 WHAT WE'RE LOOKING AT HERE THEN

427 01:20:59:09 01:21:01:06 ARE THE DEPOSITS OF A RIVER

428 01:21:01:08 01:21:03:05 THAT BUILT OUT INTO A LAKE.

429 01:21:03:07 01:21:05:21 THIS IS REFERRED TO AS A DELTA.

430 01:21:05:23 01:21:07:13 WE SEE A THICKENING

431 01:21:07:15 01:21:10:05 AND COARSENING UPWARD SEQUENCE OF BEDS.

432 01:21:10:07 01:21:12:20 THE INITIAL DEPOSITS OF THE RIVER

433 01:21:12:22 01:21:15:22 ARE THIN TO MEDIUM-BEDDED SANDSTONES

434 01:21:15:24 01:21:17:21 AND THESE REPRESENT SANDS

435 01:21:17:23 01:21:19:21 THAT JETTED OUT INTO THE LAKE

436 01:21:19:23 01:21:21:20 FROM THE MOUTH OF THE RIVER.

437 01:21:23:09 01:21:25:21 *THE RELATIVELY COARSE-GRAINED RIVER DEPOSITS*

438 01:21:25:23 01:21:28:22 *STAND IN CONTRAST TO THE FINER-GRAINED,*

439 01:21:28:24 01:21:30:06 *THINLY-BEDDED LAKE DEPOSITS.*

440 01:21:31:24 01:21:33:06 *ANOTHER SEDIMENTARY STRUCTURE,*

441 01:21:33:08 01:21:35:06 *KNOWN AS SCOUR-AND-FILL,*

442 01:21:35:08 01:21:38:06 *INDICATES THAT THE VELOCITY OF THE RIVER*

443 01:21:38:08 01:21:39:21 *FLUCTUATED OVER TIME.*

444 01:21:39:23 01:21:41:06 WITHIN THIS SANDSTONE BED,

445 01:21:41:08 01:21:43:22 WE CAN SEE A SEDIMENTARY STRUCTURE

446 01:21:43:24 01:21:46:15 REFERRED TO AS SCOUR-AND-FILL.

447 01:21:46:17 01:21:50:14 THIS IS A SURFACE RUNNING THROUGH THE ROCK RIGHT HERE.

448 01:21:50:16 01:21:53:20 WHAT WE SEE IS THAT THE UNDERLYING SANDSTONE

449 01:21:53:22 01:21:58:20 HAS BEDDING THAT'S

TRUNCATED BY THIS SURFACE.
450 01:22:00:03 01:22:02:18 WHAT THIS INDICATES
IS THAT...
451 01:22:02:20 01:22:04:20 FLOW WAS SO STRONG
452 01:22:04:22 01:22:08:05 DURING THE INITIAL DEPOSITION
OF THIS SANDSTONE
453 01:22:08:07 01:22:13:19 THAT THE CURRENT
ERODED THE PREVIOUSLY
DEPOSITED SANDS,
454 01:22:13:21 01:22:16:18 AND THEN AS THE CURRENT
VELOCITY SLOWED,
455 01:22:16:20 01:22:18:19 IT BEGAN
TO DEPOSIT MATERIAL.
456 01:22:18:21 01:22:21:22 FIRST, IT DEPOSITED
PEBBLY SANDS
457 01:22:21:24 01:22:26:20 AND ALSO DEPOSITED
THESE RIP-UP
FRAGMENTS OF MUD
458 01:22:26:22 01:22:29:04 AND THEN DEPOSITED
SAND ABOVE THAT.
459 01:22:29:06 01:22:33:04 SO WHAT WE HAVE IN THIS
SCOUR-AND-FILL SURFACE
460 01:22:33:06 01:22:36:05 IS EVIDENCE AGAIN
OF FLUCTUATING
CURRENT ACTIVITY
461 01:22:36:07 01:22:38:14 WITHIN THE RIVER CHANNEL.
462 01:22:38:16 01:22:40:29 *AT THE MARGIN*
OF THE BASIN,
463 01:22:41:01 01:22:43:14 *NEXT TO*
THE SAN GABRIEL FAULT,
464 01:22:43:16 01:22:45:14 *EVIDENCE SUGGESTS*
THAT THE FAULT
465 01:22:45:16 01:22:48:15 *WAS ACTIVE AT THE TIME*
THE BASIN FORMED.
466 01:22:48:17 01:22:50:15 WE'RE LOOKING
AT COARSE-GRAINED
467 01:22:50:17 01:22:52:20 SEDIMENTARY ROCKS
OF THE BASIN MARGIN.
468 01:22:52:22 01:22:55:05 YOU CAN SEE
THAT THE CLASTS
469 01:22:55:07 01:22:57:04 ARE LARGE
AND VERY ANGULAR
470 01:22:57:06 01:23:00:04 AND THAT THE ROCKS
ARE VERY POORLY SORTED--
471 01:23:00:06 01:23:04:02 THAT IS,
IT'S A MIXTURE OF ALL
DIFFERENT GRAIN SIZES
472 01:23:04:04 01:23:06:28 FROM SAND
ON UP TO COBBLES.
473 01:23:07:00 01:23:09:13 THE ANGULARITY
AND THE POOR SORTING
474 01:23:09:15 01:23:10:28 INDICATE
THAT THIS MATERIAL
475 01:23:11:00 01:23:14:13 HAS NOT TRAVELED
VERY FAR FROM
THE SOURCE AREA

476 01:23:14:15 01:23:16:03 AND WAS PROBABLY SHED
477 01:23:16:05 01:23:18:17 FROM THE ACTIVE
FAULT SCARP
478 01:23:18:19 01:23:20:25 AS THE BASIN
WAS DOWN-DROPPED.
479 01:23:22:05 01:23:23:16 *SEDIMENTOLOGISTS*
HAVE CONCLUDED
480 01:23:23:18 01:23:25:02 *THAT THIS FAULT ACTIVITY*
481 01:23:25:04 01:23:28:12 *COULD ITSELF HAVE CREATED*
THE RIDGE BASIN.
482 01:23:29:21 01:23:33:03 *OWING TO A BEND*
IN THE SAN GABRIEL FAULT,
483 01:23:33:05 01:23:35:17 *MOVEMENT WOULD HAVE*
STRETCHED THE CRUST
484 01:23:35:19 01:23:38:01 *IN THE AREA*
OF THE BASIN,
485 01:23:38:03 01:23:40:01 *CAUSING IT*
TO SAG DOWNWARD.
486 01:23:42:19 01:23:44:03 *THROUGH CAREFUL*
FIELD WORK
487 01:23:44:05 01:23:46:18 *COMBINING THE STUDY*
OF SEDIMENTARY ROCKS
488 01:23:46:20 01:23:48:10 *WITH LOCAL*
TECTONIC HISTORY,
489 01:23:48:12 01:23:50:10 *GEOLOGISTS HAVE*
RECONSTRUCTED
490 01:23:50:12 01:23:53:18 *A DETAILED VIEW*
OF THE ANCIENT RIDGE BASIN.
491 01:23:55:15 01:23:56:28 GEOLOGISTS USE
THEIR UNDERSTANDING
492 01:23:57:00 01:23:59:07 OF SEDIMENTARY ROCKS
TO DO MORE THAN RECONSTRUCT
493 01:23:59:09 01:24:01:04 THE HISTORY
OF THE EARTH'S SURFACE.
494 01:24:01:06 01:24:03:14 MOST OF THE ECONOMICALLY
VALUABLE RESOURCES
495 01:24:03:16 01:24:06:01 THAT ARE EXTRACTED
FROM THE EARTH'S CRUST
496 01:24:06:03 01:24:07:15 COME FROM
SEDIMENTARY ROCKS.
497 01:24:07:17 01:24:10:00 MOST PEOPLE KNOW
THAT SEDIMENTARY ROCKS
498 01:24:10:02 01:24:11:29 ARE THE SOURCE
OF FOSSIL FUELS,
499 01:24:12:01 01:24:14:14 SUCH AS OIL,
NATURAL GAS, AND COAL,
500 01:24:14:16 01:24:17:05 BUT THE ECONOMIC VALUE
OF SEDIMENTARY ROCKS
501 01:24:17:07 01:24:19:20 INFLUENCES ALMOST
EVERY PART OF OUR LIVES.
502 01:24:19:22 01:24:21:20 FOR EXAMPLE,
VIRTUALLY ALL BUILDINGS
503 01:24:21:22 01:24:24:04 AND PUBLIC STRUCTURES
REQUIRE SEDIMENTARY ROCKS
504 01:24:24:06 01:24:25:21 IN THEIR CONSTRUCTION.
505 01:24:25:23 01:24:28:06 THE CEMENT

AND SAND AND GRAVEL
506 01:24:28:08 01:24:31:05 USED TO MAKE CONCRETE,
IRON ORE FOR STEEL,
507 01:24:31:07 01:24:33:05 BAUXITE USED
IN MAKING ALUMINUM,
508 01:24:33:07 01:24:34:19 BRICK AND TILE,
509 01:24:34:21 01:24:37:05 CUTSTONE USED FOR FACING
LARGE BUILDINGS,
510 01:24:37:07 01:24:39:20 AND EVEN ASPHALT
FOR THE ROADS
511 01:24:39:22 01:24:41:21 WHICH MAKE THESE
BUILDINGS ACCESSIBLE.
512 01:24:41:23 01:24:44:06 IN FACT, ALMOST
EVERYWHERE YOU LOOK
513 01:24:44:08 01:24:45:21 YOU CAN FIND EXAMPLES
514 01:24:45:23 01:24:48:00 OF THE COMMERCIAL
AND INDUSTRIAL USES
515 01:24:48:02 01:24:49:11 OF SEDIMENTARY ROCKS.
516 01:25:14:16 01:25:15:29 *THOUGH CONSIDERABLY*
LESS DRAMATIC
517 01:25:16:01 01:25:19:15 *THAN SUCH PHENOMENA*
AS VOLCANOES OR EARTHQUAKES,
518 01:25:19:17 01:25:22:05 *SEDIMENTARY ROCKS ARE*
ULTIMATELY VERY IMPORTANT
519 01:25:22:07 01:25:23:27 *TO OUR MODERN CIVILIZATION.*
520 01:25:25:14 01:25:27:13 *NOT ONLY CAN THEY BE*
521 01:25:27:15 01:25:28:29 *ECONOMICALLY VALUABLE*
RESOURCES,
522 01:25:29:01 01:25:31:13 *BUT IN THE COMPOSITION*
AND STRUCTURE
523 01:25:31:15 01:25:33:29 *OF SEDIMENTARY ROCKS*
LIES THE BEST RECORD
524 01:25:34:01 01:25:36:12 *OF EARTH'S LONG*
AND COMPLEX HISTORY.
525 01:25:37:29 01:25:40:13 TO A GEOLOGIST,
THIS GREAT STACK OF ROCKS
526 01:25:40:15 01:25:42:28 IN THE WALLS
OF THE GRAND CANYON
527 01:25:43:00 01:25:45:12 CONTAINS A FASCINATING STORY
OF EARTH HISTORY.
528 01:25:45:14 01:25:47:28 IT'S A UNIQUE RECORD
OF CHANGING CONDITIONS
529 01:25:48:00 01:25:49:28 AT THE EARTH'S SURFACE
THROUGH TIME
530 01:25:50:00 01:25:51:13 AND A STOREHOUSE
OF INFORMATION
531 01:25:51:15 01:25:53:28 ABOUT THE MOUNTAINS
AND THE SOURCE ROCKS
532 01:25:54:00 01:25:55:12 THAT PROVIDED
THE SEDIMENTS THEMSELVES.
533 01:25:55:14 01:25:56:27 ONCE WE UNDERSTAND
THE SIGNIFICANCE
534 01:25:56:29 01:25:59:26 OF THESE ROCKS AND
OF THE CLUES THEY CONTAIN,
535 01:25:59:28 01:26:02:11 WE CAN READ THE RECORD
OF EARTH HISTORY,

536 01:26:02:13 01:26:03:25 LIKE PAGES IN A BOOK,
537 01:26:03:27 01:26:06:05 IN THE ROCKS
OF THE CANYON WALLS.
538 01:26:06:07 01:26:08:11 THE OLDEST ROCKS
IN THE CANYON
539 01:26:08:13 01:26:09:26 WERE DEPOSITED
AS SEDIMENTS
540 01:26:09:28 01:26:11:26 ABOUT TWO BILLION YEARS AGO.
541 01:26:11:28 01:26:14:11 A GREAT PILE
OF SAND AND MUD,
542 01:26:14:13 01:26:16:26 INTER-BEDDED WITH VOLCANIC
ASH AND LAVA FLOWS,
543 01:26:16:28 01:26:18:26 FILLED A RAPIDLY SUBSIDING
MARINE BASIN.
544 01:26:18:28 01:26:21:27 THESE ROCKS WERE DEFORMED
IN A MOUNTAIN BUILDING EPISODE
545 01:26:21:29 01:26:23:27 INTO AN ANCIENT
MOUNTAIN RANGE,
546 01:26:23:29 01:26:26:26 THE MAZATZAL MOUNTAINS,
ABOUT 1.5 BILLION YEARS AGO.
547 01:26:26:28 01:26:28:25 THE MOUNTAINS
WERE DEEPLY ERODED
548 01:26:28:27 01:26:30:26 AND THEN COVERED
WITH A MIXTURE
549 01:26:30:28 01:26:32:11 OF LIMESTONE AND SHALE,
550 01:26:32:13 01:26:35:10 AS SEA LEVEL ROSE
AND FLOODED THE REGION,
551 01:26:35:12 01:26:38:12 CREATING AN UNCONFORMITY
ABOUT ONE BILLION YEARS AGO.
552 01:26:38:14 01:26:40:11 MOUNTAIN BUILDING
AND VOLCANIC ACTIVITY
553 01:26:40:13 01:26:41:27 WERE THEN REACTIVATED,
554 01:26:41:29 01:26:44:25 FOLLOWED BY YET
ANOTHER RISE IN SEA LEVEL
555 01:26:44:27 01:26:47:01 AND DEPOSITION
OF MORE MARINE SEDIMENT.
556 01:26:47:03 01:26:50:00 IN FACT, THE ROCKS
OF THE GRAND CANYON
557 01:26:50:02 01:26:52:29 RECORD NO FEWER THAN FOUR
MORE REPETITIVE EPISODES
558 01:26:53:01 01:26:54:29 OF STRUCTURAL UPLIFT
AND EROSION,
559 01:26:55:01 01:26:57:11 FOLLOWED BY DEPOSITION
OF MORE SEDIMENT
560 01:26:57:13 01:26:59:25 AS SEA LEVEL
ENCROACHED ON THE LAND
561 01:26:59:27 01:27:02:24 AND NEARBY MOUNTAINS SHED
SEDIMENT INTO THE REGION.
562 01:27:02:26 01:27:04:23 AND THIS PROCESS
CONTINUES TODAY.
563 01:27:04:25 01:27:06:24 THE COLORADO RIVER
IS NOW CUTTING
564 01:27:06:26 01:27:08:09 AN EXTRAORDINARY
UNCONFORMITY SURFACE,
565 01:27:08:11 01:27:10:08 WHICH WILL EVENTUALLY
BE COVERED

566 01:27:10:10 01:27:11:20 WITH SEDIMENTS ONCE AGAIN.
567 01:27:11:22 01:27:14:08 I SOMETIMES WONDER
WHAT THE GRAND CANYON
568 01:27:14:10 01:27:16:09 WILL LOOK LIKE
WHEN THAT HAPPENS.
569 01:27:16:11 01:27:18:24 WILL IT BE COVERED
BY AN OCEAN?
570 01:27:18:26 01:27:20:24 WILL THE SEDIMENTS BE SHED
571 01:27:20:26 01:27:22:24 FROM MOUNTAINS
YET TO BE FORMED?
572 01:27:22:26 01:27:25:09 NO ONE YET KNOWS,
BUT ONE THING'S CERTAIN...
573 01:27:25:11 01:27:26:29 THE ANSWERS
WILL BE RECORDED
574 01:27:27:01 01:27:28:26 IN THE SEDIMENTARY ROCKS.
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