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WATER-INDUCED SEALING FEATURES IN AN ALLUVIAL SOIL FROM A SUB-DESERTIC AREA (AGADEZ - NIGER)

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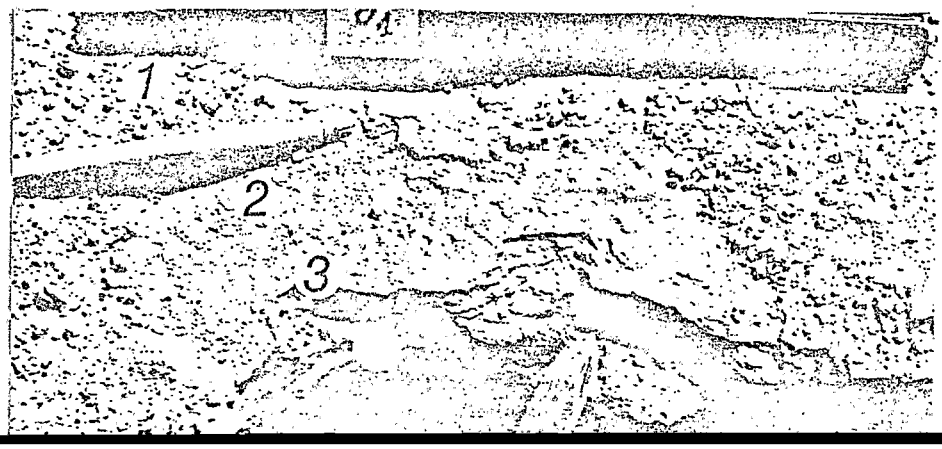
INTRODUCTION

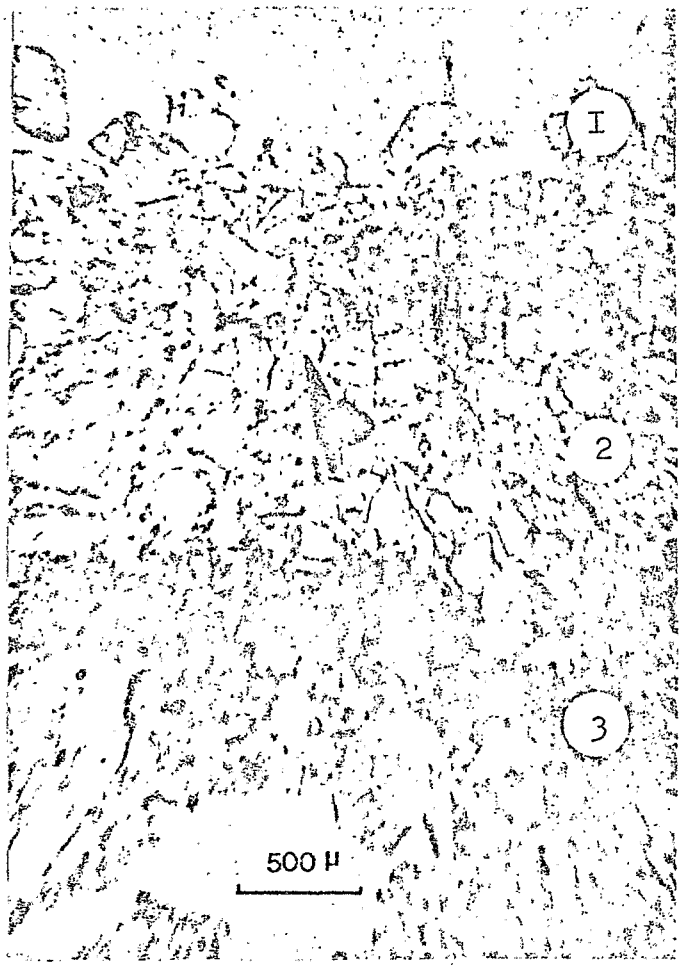
SURFACE SEALING AND LAMINATED LAYERS CAN BE OBSERVED IN A SANDY ALLUVIAL SOIL LOCATED IN THE SOUTHERN FRINGE OF THE SAHARA (AGADEZ). MORPHOLOGICAL ANALYSES COUPLED WITH AN EXPERIMENTAL STUDIES WERE ATTEMPTED IN ORDER TO PROVIDE INFORMATION



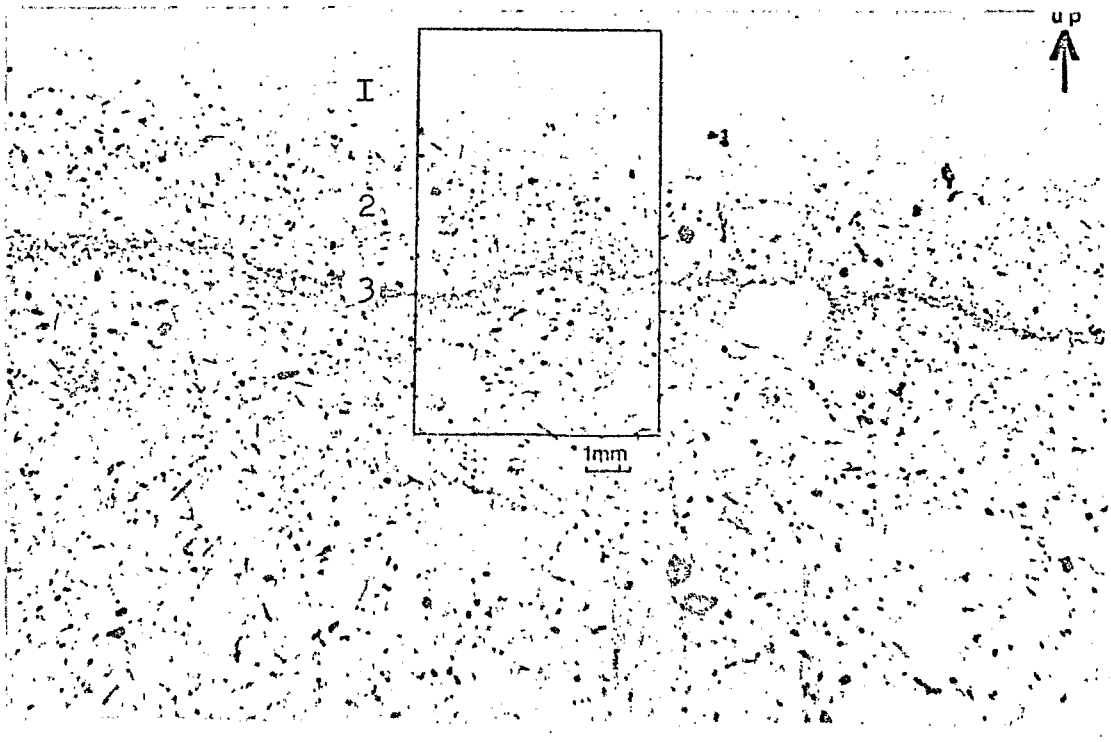
NATURAL FEATURES

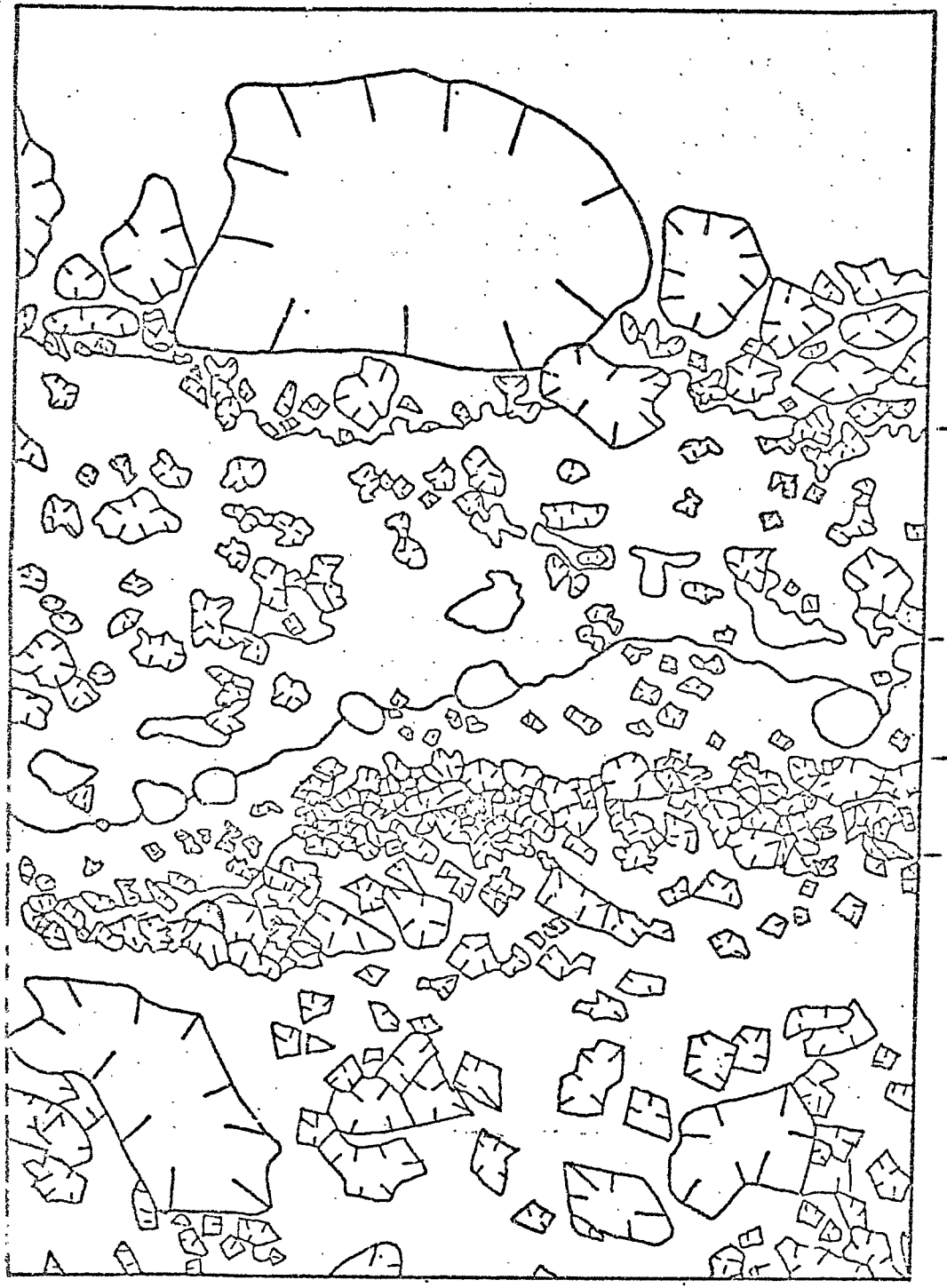
THE NATURAL MICRO-PROFILE OF THE SOIL SURFACE IS STRATIFIED. EACH STRATUM COMPRISES THREE TYPICAL MICRO-LAYERS:
(I) LOOSE GRAVEL AND COARSE SAND,
(2) CIMENTED FINE SAND,
(3) A THIN SEAL OF COHESIVE PLASMA.

VESICLES OCCUR MAINLY IN THE BOUNDARY BETWEEN THE FINE SANDS AND THE SEAL.



THIN SECTIONS OF THE UPPER MICROLAYERS OF THE NATURAL PLOT





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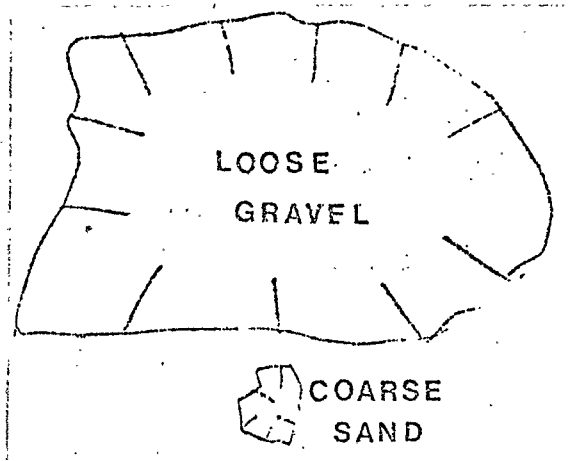

	Gravel	Coarse Sand	Fine Sand	Plasma
LOOSE GRAVEL / COARSE SAND	58	38	4	—
CIMENTED FINE SAND	—	29	71	—
VESICLE COHESIVE PLASMA	—	11	9	80
COMPACTED SAND	—	71	29	—

EVALUATION OF THE SIZE DISTRIBUTIONS OF THE NATURAL UPPER MICROLAYERS

ARTIFICIAL SEALING

1 - EQUIPMENT AND PROCEDURES

MANUAL SHALLOW PLOUGHING (0.1M) WAS PERFORMED AND NATURAL FEATURES WERE THEREBY DESTROYED. RAINFALL SIMULATION WAS THEN CONDUCTED WITH A SPRINKLING INFILTROMETER (1) IN ACCORDANCE WITH THE CLIMATIC DATA PREVAILING IN THE STUDY AREA, NAMELY RAINFALL AMOUNTS, DURATIONS, INTENSITIES AND KINETIC ENERGIES. SAMPLES WERE COLLECTED AT VARIOUS STAGES FOR SCANNING ELECTRON MICROSCOPY AND FOR MICRO-MORPHOLOGICAL ANALYSIS. THE EVOLUTION OF THE CRUST STRENGTH WAS MEASURED WITH A PENETROMETER AND RUNOFF WAS RECORDED ON 1 M^2 PLOTS.

2 - RESULTS

A - Morphological Analysis

SOIL SURFACE MICRO-PROFILE OF THE TILLED PLOT AFTER SIMULATED RAINFALL

① Loose gravel and coarse sand
② Cimented fine sand
③ Thin cohesive seal
④ Compacted tilled layer

THE MORPHOLOGY OF THE CRUSTS FORMED BOTH UNDER NATURAL CONDITIONS AND UNDER RAINFALL SIMULATION ARE VERY SIMILAR. A VERY THIN AND DENSE SKIN IS COVERED WITH COARSE PARTICLES. POROSITY IS RESTRICTED TO

SEM MICROGRAPH OF THE UPPER LAYER OF THE TILLED SOIL AFTER SIMULATED RAINFALL

2 Cimented fine sand

C - Hydraulic Properties

AFTER THE FIRST RAIN, PREPONDING RAINFALLS AND INFILTRATION RATES ARE GETTING SIMILAR FOR BOTH PLOTS, NATURAL AND PLOUGHED. ONLY A SMALL RAINFALL IS REQUIRED FOR SEALING TO OCCUR ON THE PLOUGHED SURFACE, AND THUS TO REDUCE INFILTRABILITY TO A LOW LEVEL, DESPITE THE COARSE TEXTURE OF THE MATERIAL (FINE SAND: 37 %, COARSE SAND: 53 %).

	PREPONDING RAINFALL (CM)		INFILTRATION RATE (CM/H)	
	NATURAL	PLOUGHED	NATURAL	PLOUGHED
DRY RUN	0.8	2.5	4.1	5.0
MEDIUM RUN	0.3	0.4	2.5	2.7
WET RUN	0.2	0.2	2.1	2.1

DISCUSSION

MORPHOLOGICAL ANALYSIS, SOIL STRENGTH AND HYDRAULIC PROPERTIES STUDIES SHOW THAT THE PROCESSES OF SEALING ARE MOST EFFECTIVE BEFORE THE OCCURANCE OF RUNOFF. THE COMPARISON OF THIN SECTIONS AT VARIOUS STAGES INDICATES THAT CLODS COLLAPSE RAPIDLY WHEREAS THE SAND FRACTION IS AFFECTED BY SPLASH AND FALLS AGAIN ON THE UPPERMOST MICRO-LAYER. FINE PARTICLES ARE MICRO-ILLUVIATED AND ACCUMULATE ABOVE THE ZONE BEING COMPACTED BY RAINDROPS WHILE AIR IS ENTRAPPED (2).

CONCLUSION

BOTH FEATURES AND PROPERTIES OF NATURAL AND ARTIFICIAL SEALS SUGGEST SIMILAR MECHANISMS OF FORMATION, NAMELY SEGREGATION OF PLASMA AND SKELETON UNDER RAINFALL. THEIR ARRANGEMENTS ARE THUS CONTRARY TO THE TYPICAL SEQUENCE OF SEDIMENTED MATERIALS. OWING TO THE SIMILARITY WITH SURFACE FEATURES BURIED LAMINAE CAN ALSO BE CONSIDERED AS SEDI- AND PEDO-RELICS, i.e. AS SEDIMENTED MATERIALS SUBMITTED TO SEALING AFTER DEPOSITION AND COVERED LATER BY THE FOLLOWING FLOODS. THESE FEATURES CAN BE THEREFORE ASCRIBED TO SURFACE PROCESSES IN GEOLOGICAL TIMES.

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