U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: THOUGHTS ON A MODEL HIERARCHY AND MODELING UNCERTAINTY

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PREDICTIONS OF REPOSITORY BEHAVIOR FOR 10,000 OR MORE YEARS

- MISSION
  - PROVIDE BASIS FOR JUDGING ACCEPTABILITY
- APPROACH
  - USE NUMERICAL MODELS
- PROBLEM
  - HOW CAN ANYONE BELIEVE THE RESULTS

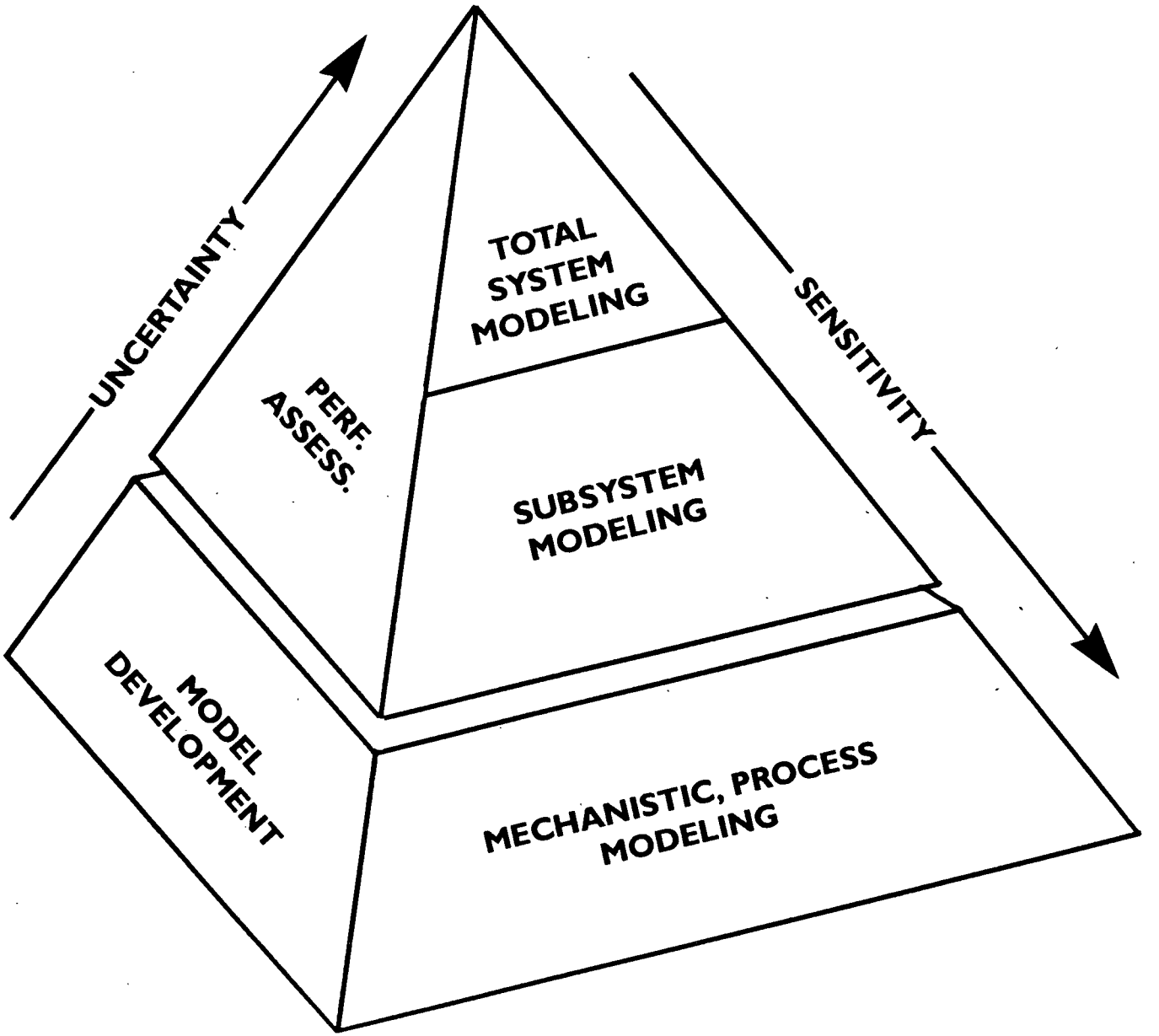
RELATION OF SUBSYSTEMS AND TOTAL-SYSTEM FUNCTIONS AND PROCESSES

SUBSYSTEM	FUNCTION	PROCESS
WASTE PACKAGE	CONTAINMENT	CORROSION OF CONTAINER MECHANICAL BREAKAGE CHEMO-MECHANICAL DAMAGE
	RELEASE CONTROL	CORROSION OF WASTE FORM RADIONUCLIDE DECAY
EBS	RELEASE CONTROL	THERMAL CHANGES TO SITE, WASTE PACKAGES CHEMICAL EFFECTS OF REPOSITORY MATERIALS
SITE	RETARD VAPOR AND GROUNDWATER FLOW	DARCY FLOW, FRACTURE AND MATRIX DISPERSION-DIFFUSION
	RETARD RADIONUCLIDE TRANSPORT	GEOCHEMICAL RETARDATION, DIFFUSION RADIONUCLIDE DECAY
	LIMIT LIKELIHOOD AND MAGNITUDE OF DELE-TERIOUS CHANGES THROUGH TIME	TECTONIC CHANGE CLIMATIC CHANGE HUMAN ACTIVITIES
TOTAL SYSTEM	LIMIT RELEASES TO ACCESSIBLE ENVIRONMENT	ALL OF THE ABOVE

RELATION OF TOTAL SYSTEM AND SUBSYSTEM ASSESSMENTS

- TOTAL-SYSTEM FUNCTION COMBINES FUNCTIONS OF SUBSYSTEMS
- PREDICTION OF SUBSYSTEM PERFORMANCE RELIES ON TIME-DEPENDENT PROCESSES IN SITE-SPECIFIC GEOMETRY
- PREDICTIONS RELY ON HIERARCHY OF MODELS
  - MECHANISTIC, PROCESS MODELS
  - SUBSYSTEM-PERFORMANCE MODELS
  - TOTAL-SYSTEM SIMULATOR

MODEL HIERARCHY



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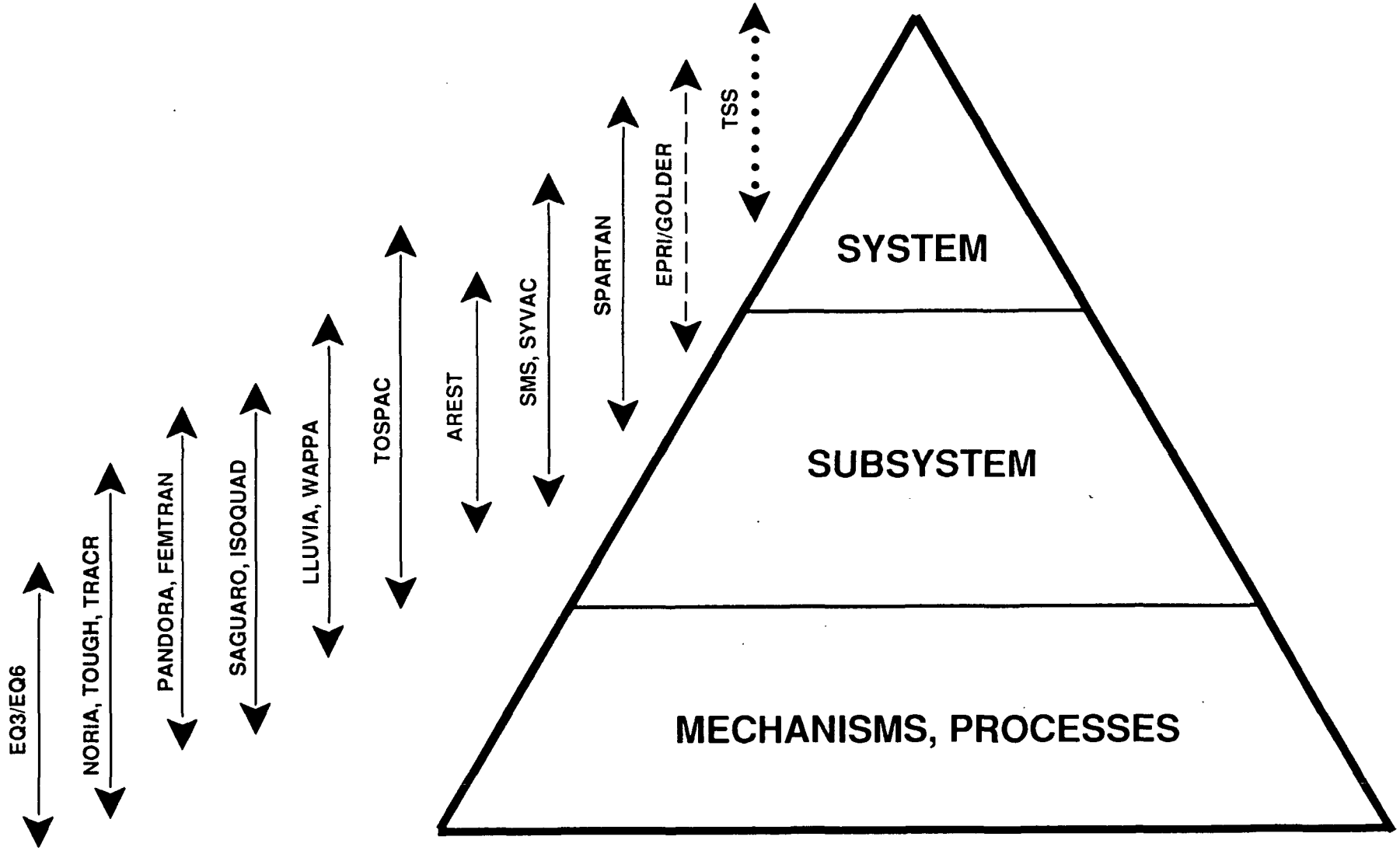
CHARACTERISTICS OF MODELS IN HIERARCHY

MODEL LEVEL	PROCESS TREATMENT	USE OF COMPUTER TIME	USE
SYSTEM	SIMPLE TO ABSENT	MULTIPLE REALIZATIONS OF MULTIPLE SCENARIOS	PREDICT TOTAL-SYSTEM RELEASES
SUBSYSTEM	SIMPLE	SOLUTION OF COMPLEX EQUATIONS	PREDICT SUBSYSTEM PERFORMANCE; DEFINE INPUT FOR TOTAL SYSTEM MODEL
MECHANISTIC	COMPLEX	SOLUTION OF COMPLEX EQUATIONS	PREDICT EFFECTS OF PROCESSES; IDENTIFY SENSITIVE PROCESSES, CONDITIONS; DEFINE INPUT FOR SUBSYSTEM MODELS

APPROXIMATE POSITIONS OF CODES IN HIERARCHY



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SOURCES OF UNCERTAINTY THROUGHOUT THE HIERARCHY

- o PARAMETER UNCERTAINTY
- o SCALAR UNCERTAINTY
- o PROCESS UNCERTAINTY
- o TEMPORAL UNCERTAINTY

STRATEGIES FOR TREATING UNCERTAINTY THROUGHOUT THE HIERARCHY

- DEFENSE IN DEPTH
- QUANTIFY PARAMETER UNCERTAINTY
- USE SIMPLIFIED MODELS TO IDENTIFY SENSITIVE PARAMETERS AND PROCESSES
- STRESS UNCERTAINTY ABOUT COMPLIANCE RATHER THAN ABOUT ACTUAL BEHAVIOR
- ACKNOWLEDGE RELIANCE ON PROFESSIONAL JUDGMENT

VIEWS ON VALIDATION OF MODEL COMPONENTS

- LOWER LEVEL (MORE MECHANISTIC) MODELS
  - ARE THE GENERAL PROCESSES PROPERLY DESCRIBED?
  - ARE THE RELEVANT PROCESSES INCLUDED?
  - DO "REPRESENTATIVE" DATA INPUTS PROVIDE RELIABLE BASES FOR ESTIMATING OF "SITE" BEHAVIOR?
- HIGHER LEVEL (LESS MECHANISTIC) MODELS
  - DO INPUT VARIABLES ADEQUATELY REPRESENT SITE VARIABILITY AT THE MODELING SCALE?
  - DO PROCESS SIMPLIFICATIONS ADEQUATELY REPRESENT THE IMPORTANT PROCESSES ?
  - ARE PROBABILITIES PROPERLY DESCRIBED?