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Automated lineament analysis to assess the geodynamic activity areas

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Abstract

In recent years the problem of geodynamic safety has moved from the category of abstract to the category of materialistic, realized in the form of geodynamic polygons. Organization of such kind of polygons is possible if there is a justification presented in the form of geodynamic zoning maps – the foundations of the geodynamic control network.

Modern methods of processing remote sensing data, such as automated classifications, lineament analysis, 3D modeling, allow obtaining cartographic materials that represent the distribution of various objects and phenomena on the earth's surface. These materials can be used for further spatial and cartographic analysis, as a source of necessary information for the adoption of industry management decisions.

In this paper, we present the results of constructing geodynamic activity maps in regional scale, compiled on the basis of the lineament analysis of the DEM.

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1. Introduction

Lineament analysis represents effective range of remote methods of mapping for monitoring of potential hazardous geological-geomorphological facilities that enables to evaluate overall geodynamic environment associated with company's mining operations. Linear structures revealed as a result of studies may be used for solution of a number of tasks, such as, definition of routes of migration of subsurface waters, search of fields of minerals, assessment of stability of geological blocks in course of design and construction of military, civil and industrial facilities etc[1-5]. Lineaments on earth surface will be identified either visually or in an automated way. Lineaments are traditionally identified visually based on topographic maps (topolineaments) and remote probing data (space lineaments). It is worth noting that this is an extremely time-consuming process. One of optimization directions may be application of automated lineament analysis in state-of-the-art GIS-programs. This type of analysis is marked with huge operational and significant economic efficiency[6].

Automated lineament analysis methodology enables to identify lineaments of various hierarchical levels, which significantly increases objectivity, and completeness of geodynamic environment in studied area associated with fractured rocks. This methodology enables evaluating tectonic fault efficiently in large areas with further geodynamic hazard forecast map development[7].

Term "lineament" is one of widely used geological terms. This term was first used by Hobbs W.N in 1904. In modern rendering[8] lineament is linear or linear organized elements of earth surface structure that directly or indirectly reflect geological structure features, including deep faults and submerged foundation fractures, which is a direct linear indicator of tectonic fault of any dimensions.

Nomenclature

DEM	Digital Elevation Model
GIS	Geoinformation System
SRTM	Shuttle Radar Topographic Mission

2. Methodology

Basic software application for analysis is a test version of GIS Geomatica (PCI Geomatics, Canada). Geomatica software is designated for analysis of data of various types – images, schemes, DEM. Geomatica is an instrument that enables obtaining uniform numeric description of distribution and orientation of fine linear figure elements. This algorithm is based on analysis of background characteristics (features) of pixel images of day surfaces that is fractures on the images are characterized by direct linear borders between plots of various brightness[9]. Fractures include small linear facilities in image scale that in reality correspond to small disjunctive faults, fragments of larger faults, technogenic facilities and false facilities in single cases(for example, shadows, clouds)[10].

It is worth noting that existing automated methods do not always identify all lineaments present in the images. This is due to the fact that this method is targeted at identification of clear direct linear elements of the image. There are no direct lineaments in solution of geological tasks – all of them, especially the largest, have been deformed by tectonic movements, weathering and overlapped by sediment cover to various degrees. This complicates their automated identification on the images, especially highly accurate, where unclear identified borders of large lineaments may deviate from the line. Such facilities are confidently identified on the images with smaller resolution, however, smaller lineaments are not identified in the latter images[11].