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FOUNDATIONS OF THE MORPHOGRAPHY OF CARTOGRAPHICAL SYMBOLS

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Semiology as the general theory of symbols does not inquire into principles in forming the symbols in details, namely for the individual spheres of their application. Linguistics by itself has worked out a systematics of verbal symbols in the form of a lexicon, morphology, syntax and style. Similarly cartography must solve by itself the organization of its own symbolic representation. In investigating this problem we can go out from morphographic symptoms of cartographic symbols, which form logically closed systems on the individual maps or their series and sets. Each cartographical symbol from such a system may be examined as a graphical and meaningful compound word — a syntagma (cartosyntagma) — consisting of such a number of graphic elements, that also the meaning designed by symbol consists of. It means that within a cartographical symbols one can abstract out a graphical invariant, morphemes and graphemes including graphical motives and graphematic spaces. From these elements, on the basis of different connection of submeanings various new symbol may be formed (or their various modifications derived) by means of morphographical operations, namely affixation, conjugation, rotation, conversion, specular, positive-negative one), mutation (colour, outline), pretextation, sublinearization, magnification, distribution, screening, penetration and complementation.

INTRODUCTION

As far as symbol designation in the maps had been simple, not too complicated and as far as it concerned in particular the mapping of topographical surface of the Earth, it was not necessary to consider any special organization of this manner of symbolic representation. Nevertheless, the development of symbolic systems continued and in topographical maps it was characterized by a gradual modernization of initial iconic (motivated) symbols.

As early as the 19th century the cartographic representation worked itself from primitive schematic-perspective drawings up to abstract-conventional sym-

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bols, which towards this time began forming fairly complicated systems on topical maps and in complexful atlases. Semiology, which arose at the beginning of this century and whose developing persons were particularly Ch. Peirce, Ch. Morris and others, in spite of all it persisted in by-passing cartographical symbols as examples of symbolic systems, obviously being convinced that those symbols are still of an iconic character. Semiology simply did not registered the violent boom in topical cartography (to the detriment of both) and as far as it is known, from European semiologists V. Voigt (originally an ethnographer) only used an example from meteorological charts in explaining properties of the symbols (10).

Semiology is a science engaged in symbols in general, not devoting to more detailed specifics of symbols from the individual spheres (e. g. to linguistic, folkloric, mathematical, ... cartographical symbols). It reckons with the fact that the specific problems will be solved and developed by each concerned sphere itself as it was made, for instance, by linguistics. Attempts to apply the generally known division of semiology into semantics, syntactics and pragmatics appeared in cartography, however, without an appropriate deepening to cartographical conditions. In our opinion Prof. L. Ratajski's endeavour after working out „a grammar“ of the map language from 1976 (7) is to be ordered from among them to those unusually interesting. We wish he had been able to bring up more aspects of this problem (he died in a short time). In our investigations we took up these positive ideas of L. Ratajski and in 1982 we enunciated a hypothesis of a linguistic character of cartographical representation and at the same time also an opinion of its organization, which could consist of cartographical signics (symbol stock level), morphology (symbol-forming level), syntax (symbol-syntactic level), or also stylistics (stylistic level, that of style).

In this article our ideas of morphographical properties of cartographical symbols should be made more precise.

FORM, MEANING AND POSITION OF THE CARTOGRAPHICAL SYMBOL

To be able to fulfil its function, every cartographical symbol must comply with three basic conditions in one, namely it must possess a form (graphical appearance), meaning (content of thought) and position (in coordinate system adopted). A cartographical symbol possesses several functional conditions, but we have named these three attributes, or properties, the basic cartographical triad (6). A symbol possessing only a couple of properties, either a form and meaning without a position is irrelevant in the map, or similarly, a symbol possessing a form and position but without meaning (and anyway senseless is to speak about the meaning together with position — without a form).

THE FORM

We have got some primary knowledge of the form of cartographical symbol, namely from J. Bertin (1), that the basis of any graphico-symbolic representation (and thus also of the cartographic one) is a graphic element (spot,

stain), which is able to change 6 properties (graphically variable): the shape, size, intensity, structure, colour and orientation.

If we examine cartographical symbols as systems, which have up to the present been used in maps, also in the way of an empiric-theoretical generalization, then we find that there are some more properties that are able to change the graphical aspect of a symbol in accordance with a diversity or affinity in the meaning of individual symbols in comprehensive symbol systems. The ways, or manners, by which the form (graphical appearance, shape, shaping) of a symbol may be alternated, have been named morphographical operations by us. We devote attention to them in a further part of this contribution.

THE MEANING

In the moment we have only a relatively a small knowledge about the bond of the form of cartographical symbol to heterogeneous meanings (semantic contents). In a certain sense we have dealt with this problem in an article about necessity and voluntariness in cartography [5], calling attention to existence of the law of associativeness, which distinguishes between a profitable motivateness of the symbol with its meaning in cartography and an analogical bond in other systems, for instance, in the natural language, where this bond is on principle non-motivated, i. e. unassociative one.

Originally, in consequence of exaggeratedly empiric generalizations an opinion existed in cartography, based particularly on topographical maps, that every real object (O) is directly designated by symbol (S), for instance, such an object as „a bridge“ (Fig. 1), i. e. it was inferred that relation

$$O \longrightarrow S$$

holds good.

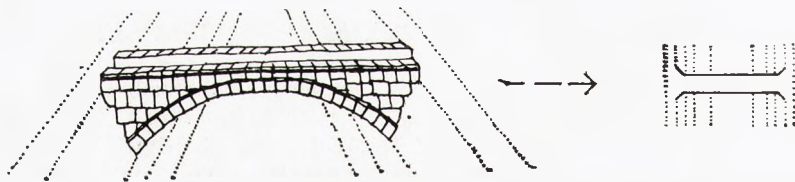


Fig. 1. The real object of a „bridge“ related to its designation by a symbol in the map. A direct relation between the object and the symbol is only illusory.

However, we know from semiology (but also from gnoseology and logics) that no object (or phenomenon) is designated directly, but its meaning (M), and thus relation holds good as follows:

$$O \longrightarrow M \longrightarrow S$$

This mediated relation between a symbol and the object through the meaning was confirmed also in topical cartography (in topical maps). Thus only thanks

to this conformation cartographers were ready to recognize that this principle holds good also in topographical maps, namely also in our case, in symbol designation of the object „bridge“. The object „bridge“ as such may be conceived from different aspects, in various meanings, for instance, as „a building connecting the edges of a hollow or chasm“, further as „an establishment to get over a deepened hindrance“, or as „an engineering construction on the way, or railway“, „a potential obstacle for surface communications“ and so on. The different modifications of standpoints to bridges as objects mean at the same time also different modifications of their meanings.

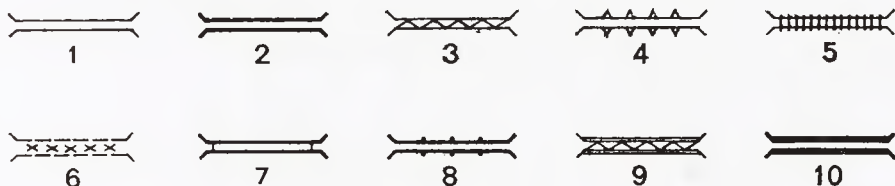


Fig. 2. Symbols of various bridges in topographical maps: 1 — wooden bridge, 2 — masonry (concrete) bridge, 3 — metallic (railway) bridge, 4 — pontoon bridge, 5 — chain (rope) bridge, 6 — scaffold bridge, 7 — masonry bridge with steps 8 — masonry bridge with fields, 9 — two-storeyed bridge with railway over a road, 10 — two-storeyed bridge with road over a railway.

There is an illustration of symbols for 10 different bridges in Fig. 2. It is ostentatively clear to what extent the individual symbols differ each from the other in the meaning, or how far they are close each to the other according to closeness of their meanings. In individual meanings also some characteristics are included at the same time, for instance, the kind of material used, length, width — and after implanting them into the map also orientation to the cardinal points (and in this way also to other objects). All these cases are borrowed from topographical maps. From the illustration it is clear that a quantity of meanings of this object still remain, which are not designated by cartographical symbols (as to the given set), for instance, the typ of construction, architectural design, the way of contact with the riversides, altitude over the river, the height of the construction proper, pavement lay-out and so on.

The meaning is a fairly complicated category, we are able more intuitively come to feel its substance than to define it. It is contiguous with and in part it overlaps such categories like a reflection in gnoseology and philosophy, an idea, sensual content and concept in logics, a psychological content in psychology, an image in drawing, painting, sculpture, music and belles lettres, and so on. In cartography the meaning plays a deciding symbol-forming (morphological, morphographical) part in relation to graphical form of the symbol.

THE POSITION

The function of symbol position is of a striking and specific sense in cartography. Also in linguistics the position of a word (as a linguistic symbol in

the system of linear sequence of words] has an important message: a variation in word-order within a sentence conveys also an alteration of the general meaning, or also that there is only a certain reduced freedom in word-order of the given language. An unambiguous location of symbols within the map field is characteristic for cartography, but in spite of this fact we can distinguish two cases of symbol position in the map:

a) a mathematically exact position of the symbol within an adopted system of coordinates with accuracy required or enabled by the scale of a map, and

b) a relatively looser position, for instance, the position of a diagrammatic symbol within an areal cartodiagram, the position of an approximate boundary and so on. Nevertheless, criteria, or limits, in general definable and prevalently logic, hold good also for such a looser location of the symbol on a map. The position of a symbol is, however, of a smaller significance; it has a much more important function in cartographical syntax.

MORPHOGRAPHIC SYMPTOMS OF CARTOGRAPHIC SYMBOLS

From Fig. 2, in a way of gradual generalizations, we are able to derive some theoretical conclusions, namely:

— The symbols of bridges form a class self-standing in the meaning and also graphically (analogically as the symbols of various ways, rivers, growths and other meaningful groupings on topographical maps, but also on other ones).



Fig. 3. Graphical invariant of the symbol of a bridge (an imaginary principle of the symbol).

— A common graphical invariant (Fig. 3) may be abstracted out from this series, and from this one, in turn, all the symbols of bridges given in Fig. 2 may be derived reversely.

— Each symbol of the bridge may be considered as a compound word consisting of such a number of parts (elements) that the general meaning of symbol consists of. For instance, the symbol (S) No 9 in Fig. 2 (a two-storeyed bridge with railway over a way) consists of three meaningful and graphical elements (Fig. 4):



Fig. 4. Three both meaningful and graphical elements as composed in symbol S (two-storeyed bridge with railway over a road: M_1 — metallic [railway] bridge, M_2 — two-storeyed . . . , M_3 — with railway over a road: M_1 , M_2 , M_3 — morphemes, S — symbol, syntagma.

- a) a bridge (metallic, railway one — M_1 ,
- b) a bridge, two-storeyed — M_2 ,
- c) a bridge, two-storeyed, with railway over a road — M_3 .

— The principle of composing this symbol is, in fact, morphographical: elements M_1 , M_2 and M_3 are morphemes (cartographical morphemes, cartomorphemes) and they result in a compound-symbol [cartographical syntagma, carto-syntagma). This conclusion can be verified at various cartographical symbols, for instance, also at symbols of single-track and double-track lines (Fig. 5).

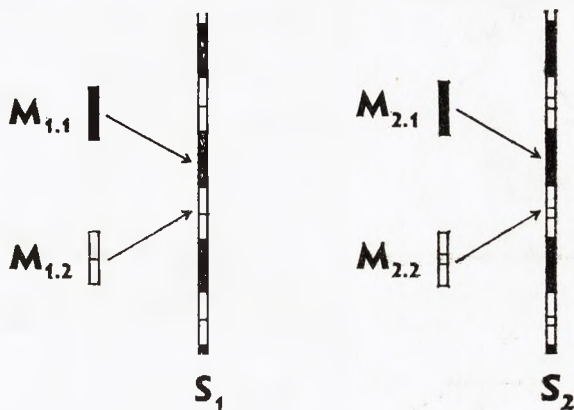


Fig. 5. An example of railway symbol composition: S_1 — single-track railway, S_2 — double-track railway, $M_{1.1}$ and $M_{2.1}$ — railways, $M_{1.2}$ — single-track ... , $M_{2.2}$ — double-track ...

Applying the principle of repeatableness of symbols S_1 and S_2 we are able to connect on the map the particular settlements (points in the map) by a resulting symbol of railway in harmony with its course in reality.

— Nevertheless syntagmas and morphemes do not exhaust the variety of cartographical symbols. In Fig. 6 morphographical decomposition of figural symbol S_F is illustrated, in Fig. 7 there is a decomposition of linear symbol S_L and in Fig. 8 decomposition of a structuralized [patternful] areal symbol S_p . From these illustrations we are able to become convinced that morphemes (M) are still divisible into graphemes (G) consisting of a graphematic (graphic) motif (G_{mo}) and graphematic space (G_{pr}). In symbols that appear in the given cartographical (symbolic) system as undivisible by meaning so as, for instance, in symbols in Fig. 9, it is irrelevant to think of a divisibility into morphemes and graphemes and therefore it holds good for them:

$$S = M = G$$

but also these symbols have their own graphical motif and graphematic space.

— If we generalize all the conclusions above-mentioned, we are able to arrange a general morphological scheme (Fig. 10), where the full arrows mean the morphological decomposition and the broken ones do the morphological

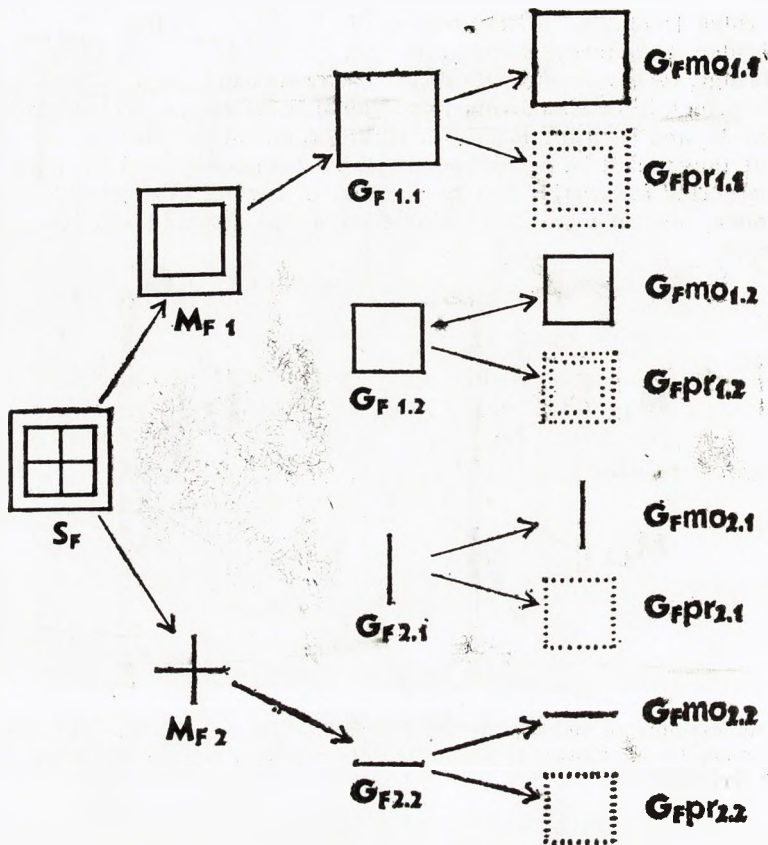


Fig. 6. Morphographical analysis of figural symbol S_F : M — morphemes, G — graphemes, G_{mo} — graphematic (graphic) motifs, G_{pr} — graphematic spaces.

composition of every cartographical symbol within the cartographical symbolic system.

So far only general designations of the syntagma, morphemes, graphemes and their elements [S , M , G , G_{mo} , G_{pr}] appear in the scheme, we task of a morphological scheme, if, however, particular graphic forms (as for instance those in Figs. 6, 7 and 8) appear in it, then we talk of a morphographical scheme.

MORPHOGRAPHICAL OPERATIONS WITH CARTOGRAPHICAL SYMBOLS

The morphographical operations are manners, or graphical approaches, by means of which a graphical invariant (in practice it is usually also a chosen symbol put as a representative of a symbol class) acquires various graphical forms. Morphographical, however, are only those and such operations, by which

the imaginary invariant or the symbol put (symbol principle) are graphically visualized or changed to an extent that every new (or derived) symbol may be bearer of a distinct (or derived) meaning within the framework of the delimited system of meanings of the particular map or map series (a set).

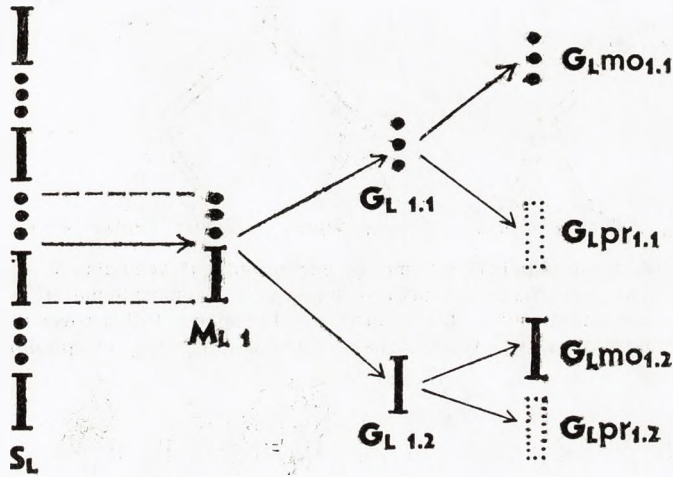


Fig. 7. Morphographical analysis of linear symbol S_L : M — morphemes, G — graphemes, G_{mo} — graphematic (graphic) motifs, G_{pr} — graphematic spaces.

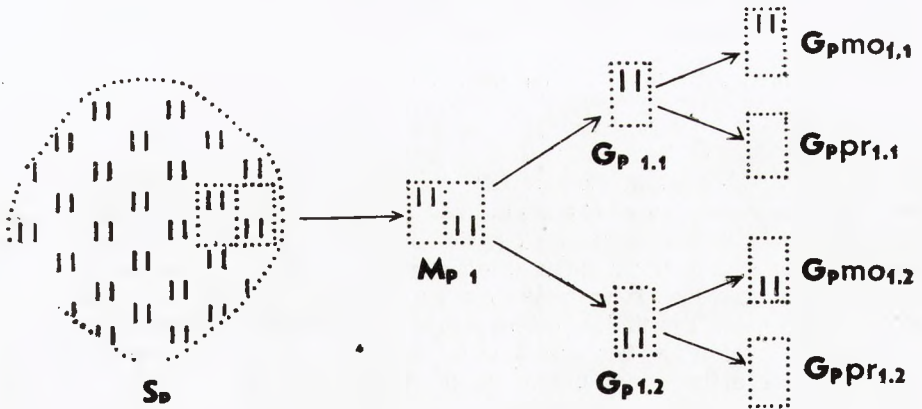


Fig. 8. Morphographical analysis of areal symbol S_p : M — morphemes, G — graphemes, G_{mo} — graphematic (graphic) motifs, G_{pr} — graphematic spaces.



Fig. 9. Symbols appearing in the symbol system of a particular map as indivisible ($S = M = G$).

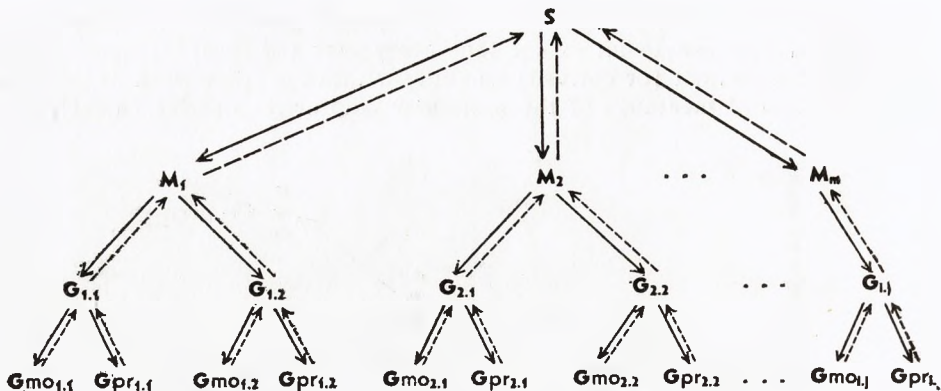


Fig. 10. A general morphological scheme of cartographical symbols: S — cartographical symbol, a syntagma (cartosyntagma), M — morpheme, G — grapheme, G_{mo} — graphical motif, G_{pr} — graphematic space; full arrows mean morphological decomposition, while broken ones do, in turn, morphological composition.

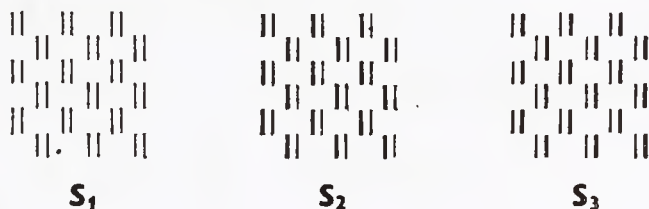


Fig. 11. An example of using affixation principle: S_1 — grass cover, S_2 — grass cover used as pasture, S_3 — grass cover used for hay.

1. *Affixation*: If original symbol (S), for instance, for the meaning, or the concept „grass cover“ (Fig. 11) is changed in such a way that the fore line in its graphical motif is thickened (S_2), we obtain a sufficiently distinct, but at the same time also a sufficiently allied symbol for the meaning „grass cover employed as a pasture“. If we make the back line more thick, we obtain symbol S_3 , for instance, for the meaning „grass cover employed for the hay“. The change of the symbol has been reached by means of the operation of affixation. The concept of affix is not unknown in cartography. In his outlines of the grammar of cartographical language [7], L. Ratajski took into consideration, as early as 1976, six kinds of affixes: inner (infix), outer (exfix), left (prefix), right (postfix), lower (infracfix) and upper (ultrafix). We are of the opinion that affixes distinguished according to position related to the graphical invariant may be several, 48 of them being illustrated in Fig. 12. We have arranged Ratajski's terminology only in the case of the upper affix. Also other affixes still exist, distinguished according to the shape, frequency and some other criteria (a part of them is illustrated in Fig. 13). From the functional viewpoint one can still distinguish for instance: morphofix (meaningful, morpho-forming),

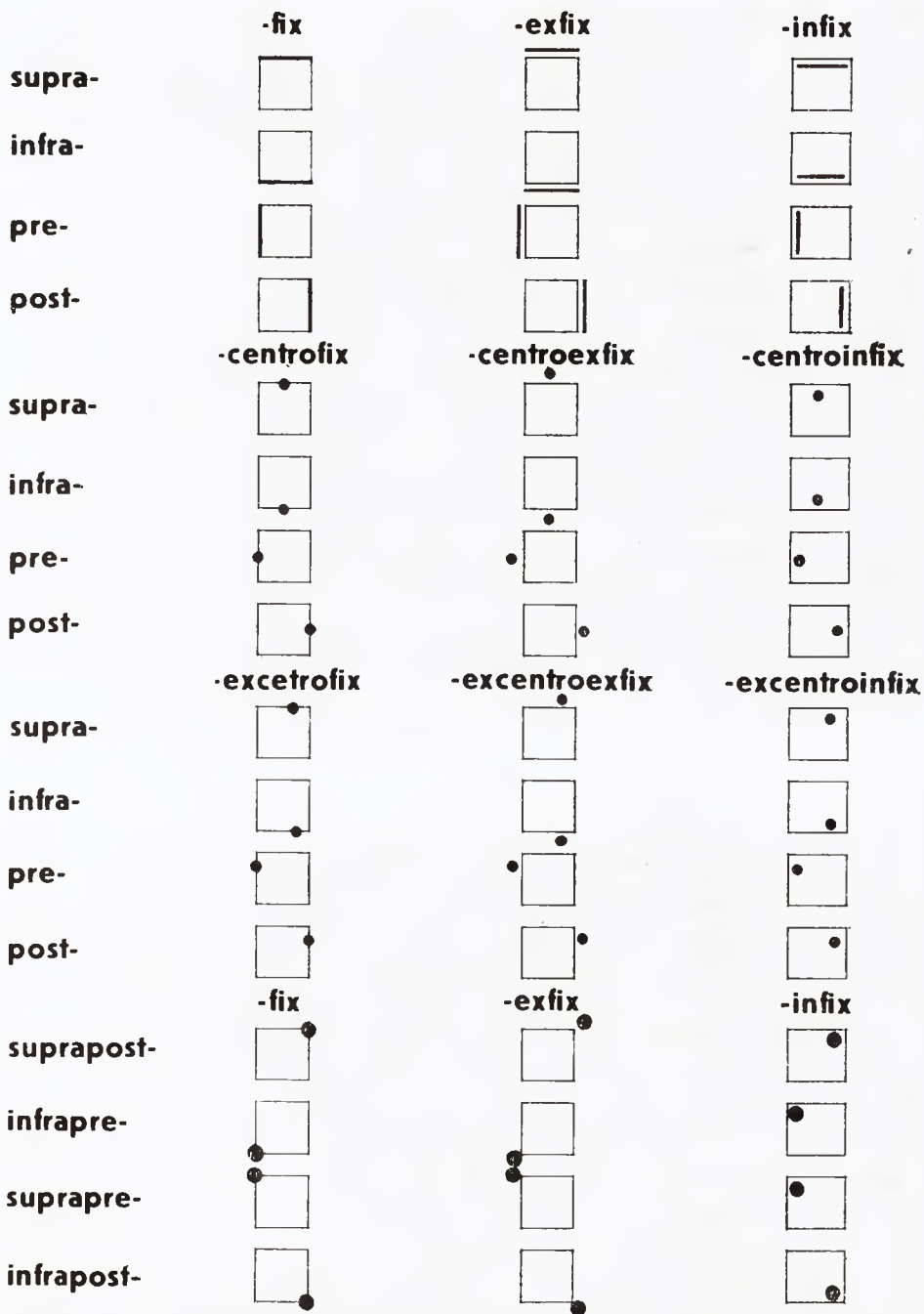


Fig. 12. A scheme of affixes according to position towards graphical invariant of the symbol.

adfix (adjective), colorfix (coloured), spatiofix (spatial, that of volume), umbrafix (that of shadow), demitonfix (that of half-tone), arealfix (that of area), principalfix (that of half-tone), arealfix (that of area), principalfix (basic, main), alterfix (secondary, supplementary), alternusfix (alternating), primusfix (first), secundusfix (second), tertiafix (third), minifix (small), maxifix (large), confix (connecting), solofix (individual) ... etc.





	centrofix, centroinfix
	simplifix
	duplifix
	triplifix
	contrafix
	interfix
	longfix
	brefix
	konkávfix
	konvexfix
	directfix
	tenfix
	crasfix
	luxfix
	punctfix
	circulusfix
	ovalfix
	elipsifix
	trigonfix
	quadratrix
	pentagonfix
	sexagonfix
	gravisfix
	levisfix
	lineafix
	parsfix
	acerfix

Fig. 13. Illustration of some affixes, distinguished by the shape, frequency and other criteria.

To differentiate these affixes, for instance, from those in linguistics, we can name them cartoaffixes and the whole morphological operation, in turn, a cartoaffixation. In a similar way we can get along also with the names of further operations.

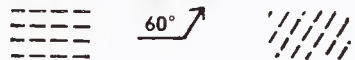
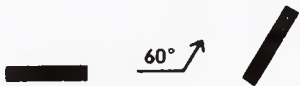
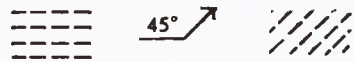
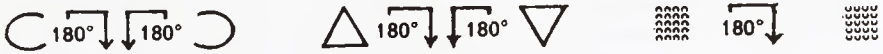
2. *Conjugation*. Under this term we understand various ways of connecting, associating, composing to amalgamating graphical elements of a symbol. They are as follows:

- liberation (loose, irregular connecting, associating),
- contouration (connecting by making contouration),
- composition (composing, ordering, arranging):
- configuration (arranging to a figure, or shape),
- versification (ordering to a line),
- columellation (ordering to a column),
- coursification (ordering to a course),
- duplexation (doubling),
- triplexation (tripling),
- alternation (arranging by turns),
- ordination (arranging to a regular structure, or network),
- texturation (arranging to a pattern, texture), and so on,
- consociation (amalgamation) — Fig. 14:
 - that by parity (equivalent),
 - that by subordination (subordinate).

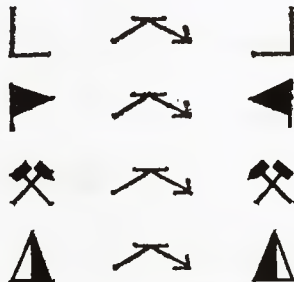


Fig. 14. Illustration of the morphographical operation of consociation: *a* — consociation by parity, *b* — consociation by subordination.

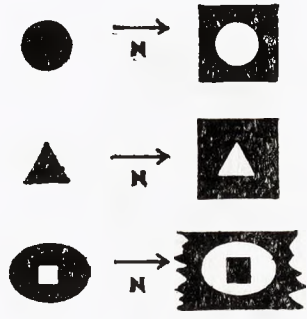
3. *Rotation* (moving round a point, a change in orientation) by 90° , 180° , 30° , 45° , 60° or also by other angles



4. *Specular conversion*



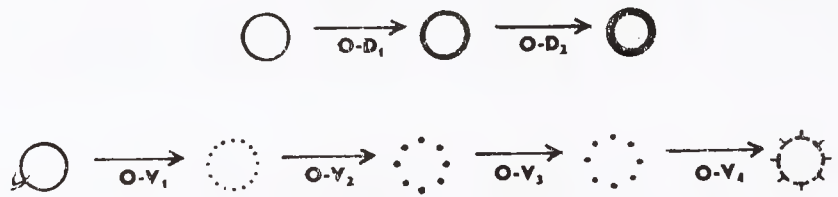
5. *Conversion from positive to negative*



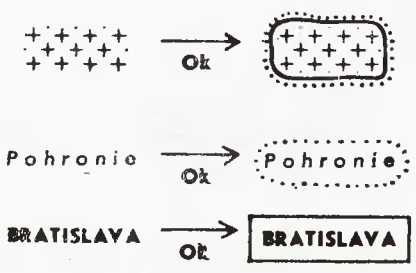
6. *Screening* (change in intensity)

7. *Mutation of colour* (change in hue, in shade)

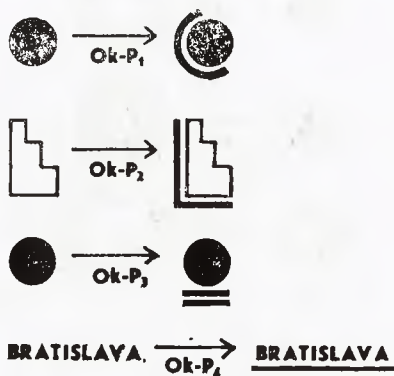
8. *Mutation of outline* — by dimension, by making a pattern (by structuralizing)



9. *Pretextation* (edging)



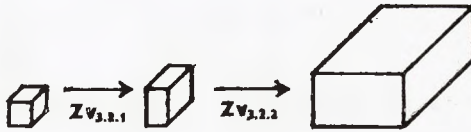
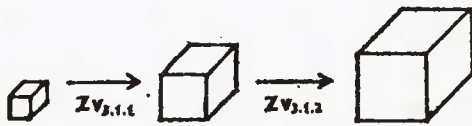
10. *Sublinearization* (underlining),



11. *Magnification* (enlarging):

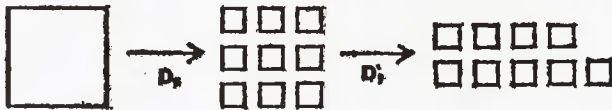
- a) enlarging of one dimension,
- b) enlarging of two dimensions — directions, (equally, differently),
- c) enlarging of three dimensions — directions (equally, differently),
- d) enlarging of graphic-element distances, for instance, within areal patternful (structuralized) symbols



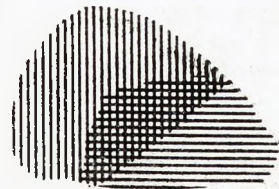


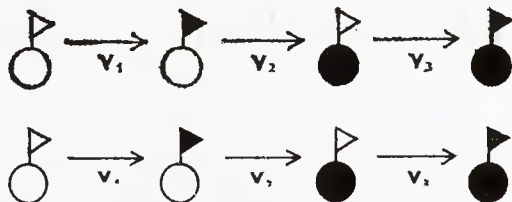
12. *Distribution* (division, representing by number of elements):

- a) compact,
- b) non-compact



13. *Penetration* (lay, overlap)





The overview of cartographical morphographical operations is not definitive. There are some other operations in symbol-forming, which can be interpreted from different viewpoints and therefore it has been difficult to classify them into this overview. It is supposed that in consequence of further investigations it will be possible to set up a system of morphographical operations, well-thought-out both formally and by content, which will support mobility apparent already at present in cartographical symbol-forming.

CONCLUSION

The recognizing research in cartography faces many significant problems so far unsolved. Most of them bear relation with two mutually consequential directions in cartographical recognizing.

One of them is such a recognizing encompassing man of objective reality nature, society), i. e. such a crystallizing of thinking manner, that is directed at a cartographical form of statement or expressing. In concerns not only cartographers proper, but also all the specialists (geographers, geologists, ... etc.) that explore their problems in the spatial aspect and that the cartographical manner of expressing is more suitable for in comparison with other expressing manners.

The other direction lies in deepening of recognizing about means and approaches used at cartographical expressing. There is no unity in this direction among cartographers (but also among other specialists). Ones of them are of the opinion that at cartographical representing (expressing) reality it is sufficient to choose a complete portion from the large set of cartographical representation means with a considerable dose of arbitrariness, to designate with them objects and phenomena mapped and not to see a special learned problem in it. The others, in turn, are of the opinion that certain scientifically reasoned rules (even laws) must hold good for the symbol designation in cartography, which lower substantially the rate of arbitrariness, doing it to some alternatives only. They are convinced that the cartographical symbol representation is a special kind of formalized language (2, 3, 4, 7) or that it is a map symbolism as a special semiotic system (8, 9).

Opinions about the morphography of cartographical symbols mentioned in this article are at no variance with either linguistic, or symbolistic conceptions of cartographical representation.

REFERENCES

1. BERTIN, J.: *Graphische Semiologie. Diagramme, Netze, Karten.* Walter de Gruyter, Berlin—New York 1974, 430 p. — 2. LYUTYY, A. A.: *Yazyk karty. Znanie*, Moscow 1981,

48 p. — 3. LYUTYY, A. A.: O suschnosti yazyka karty. Geografia i prirodnye resursy, 3, 1985, pp. 142—151. — 4. PRAVDA, J.: Kartografia i kartografický jazyk. Geogr. Čas., 34, 4, 1982, pp. 343—368. — 5. PRAVDA, J.: K problému nevyhnutnosti a ľubovoľnosti v kartografii. Geografický a kartografický obzor, 33/75, 5, 1987, pp. 121—127. — 6. PRAVDA, J.: K poznávacej koncepcii kartografie. Geogr. Čas., 39, 3, 1987, pp. 257—271. — 7. RATAJSKI, L.: Pewne aspekty gramatyki języka mapy. Polski przegląd kartograficzny, 8, 2, 1976, pp. 49—61. — 8. SCHLICHTMANN, H.: Discussion of C Grant Head „The Map as Natural Language. A Paradigm for Understanding“. Cartographica, 21, 1, 1984, pp. 33—36. — 9. SCHLICHTMANN, H.: Characteristic Traits of the Semiotic System „Map Symbolism“. The Cartographic Journal, 22, 1985, pp. 23—30. — 10. VOIGT, V.: Úvod do semiotiky. Tatran, Bratislava 1981, 256 p.

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ZÁKLADY MORFOGRAFIE KARTOGRAFICKÝCH ZNAKOV

Vývoj znakového označovania v kartografii dospel v súčasnosti do takého štádia, že v uzavretých znakových systémoch (na jednotlivých mapách, na ich sériách, súboroch) sa vytvárajú rôzne druhy väzieb, súvislostí a vzťahov medzi grafickými prvkami a významovými zložkami kartografických znakov. V článku sa krátko rozoberá vzájomný vzťah medzi formou (grafickou podobou), významom (mysleným obsahom) a polohou znaku, ktoré tvoria základnú kartografickú triádu. Dokazuje sa, že na mapách (nielen tematických, ale aj topografických) objekty a javy neoznačujeme znakom priamo, ale sprostredkovane cez ich významy. Významy zohrávajú súčasne dôležitú znakovnú (morfografickú) funkciu. Na príklade znakového označenia série významov objektu „most“ sa ilustruje súvislosť jeho 10 významov so zodpovedajúcim počtom grafických podob (obr. 2) znaku „most“, používaných na topografických mapách. Spoločným menovateľom všetkých týchto znakov mostu je jeden myslený grafický invariant (obr. 3), čo zodpovedá skutočnosti, že vo všetkých významoch mostu existuje jeden spoločný významový ekvivalent („most“). Obrázok 4 dokazuje existenciu troch významových a súčasne aj grafických zložiek (morfém) jedného zo znakov mostu. Na základe analýzy konkrétneho figurálneho, lineárneho a areálového znaku sa ilustruje aj existencia najmenších grafických prvkov znaku — grafém, ktoré sa skladajú z grafického motívu a grafematického priestoru (obr. 6, 7 a 8). Kartografický znak je potom zloženina, syntagma.

Ak zovšeobecníme tieto morfológické príznaky, môžeme prísť k záveru, že pre kartografické znaky platí všeobecná morfológická schéma (obr. 10) ako princíp ich graficko-významového rozkladania a skladania.

Spôsoby, grafické prístupy, pomocou ktorých môžeme skladať graficko-významové prvky do kartografických znakov, sú morfológické operácie, ktorých sa zatiaľ vyčlenilo 14.

Afixácia je operácia, ktorá umožňuje vytvárať kartografické znaky pomocou doplnujúcich grafických prvkov — afixov. Šesť afixov, rozlišovaných podľa polohy, vyčlenil r. 1976 L. Ratajski, ale zistili sme, že ich existuje viac (obr. 12). Ďalej existujú afixy rozlišované podľa tvaru, početnosti a rôznych iných hľadísk.

Konjugácia je operácia spojenia, združovania až zlučovania grafických elementov pomocou liberácie (voľného, nepravidelného spojenia), konturácie (spojenia okontúrovaním), kompozície prostredníctvom konfigurácie (usporiadania do určitej figúry, tvaru), verzifikácie (zoraďovania do riadku), kolumelácie (zoraďovania do stĺpca), kurzifikácie (zoraďovania do určitého smeru), duplexácie, triplexácie (zdvojovania, strojovania), ordinácie (usporiadania do pravidelnej štruktúry, siete), alternácie (striedania) a texturácie (usporiadania do určitej vzorky, textúry). Ďalej sem patrí operácia konsociácie

[zlučovania] tak paritnej [rovnoznačnej], ako aj subordinačnej [podriadenej], ktorú v r. 1976 tiež vyčlenil L. Ratajski, ale nazval ju kompozíciou.

Bez podrobnejšieho vysvetľovania sa v článku uvádzajú a ilustrujú na príkladoch ostatné operácie: rotácia, [pootočenie, zmena orientácie], konvertácia spekulárna [zrkadlové prevrátenie], konvertácia pozitív-negatív, rastrovanie [zmena intenzity], mutácia farby [tónu, odtieňa], mutácia obrýsu [dimenziou, vzorkovaním], pretezácia [le-movanie], sublinearizácia [podčiarkovanie], magnifikácia [zväčšovanie], distribúcia [de-lenie], penetrácia [naloženie, prekryt, prienik] a komplementácia [vyplňovanie].

Prehľad morfografických operácií sa nepovažuje za konečný, ráta sa s jeho dopĺňaním podľa toho, ako sa budú prehĺbovať naše poznatky v oblasti kartografickej znakov-tvorby.

V závere sa hovorí, že poznávací výskum v kartografii súvisí s dvoma smermi: kartografického poznávania. Jedným smerom je poznávanie objektívnej reality (prírody, spoločnosti), ktoré je vyhranené mapovou formou výpovede. Druhým smerom je prehĺbovanie poznania o prostriedkoch a prístupoch vlastného kartografického vyjadro-vacieho spôsobu ako systému. Zatiaľ prevládajú dva názory na organizáciu tohto systé-mu. Podľa jedného sa tento systém považuje za formalizovaný [kartografický] jazyk, podľa druhého je to mapový symbolizmus ako špeciálny semiotický systém. Predstavy o morfografii kartografických znakov, prezentované v tomto článku, nie sú v rozpore ani s jedným z týchto názorov.

Obr. 1. Vzťah reálneho objektu „most“ a jeho označenie znakom na mape. Priamy vzťah objektu a znaku je len zdanlivý.

Obr. 2. Znak pre rôzne mosty na topografických mapách: 1 — most drevený, 2 — most murovaný (betónový), 3 — most kovový [železničný], 4 — most na pontónoch, 5 — most reťazový (lanový), 6 — most lešenový, 7 — most murovaný so stupňami, 8 — most murovaný s poľami, 9 — most dvojposchodový so železnicou nad cestou, 10 — most dvojposchodový s cestou nad železnicou.

Obr. 3. Grafický invariát znaku most [myslený princíp znaku].

Obr. 4. Zloženie troch významových a grafických prvkov v znaku S [most dvojposchodový so železnicou nad cestou]: M_1 — most kokový [železničný], M_2 — ... dvojposchodový, M_3 — ... so železnicou nad cestou, M_1, M_2, M_3 — morfémy, S — znak, syntagma.

Obr. 5. Príklad zloženia znaku železnice: S_1 — železnica jednokoľajná, S_2 — železnica dvojkolejná, $M_{1,1}$ a $M_{2,1}$ — železnica, $M_{1,2}$ — ... jednokoľajná, $M_{2,2}$ — ... dvojkolejná.

Obr. 6. Morfografická analýza figurálneho znaku S_F : M — morfémy, G — grafémy, G_{mo} — grafematické (grafické) motívy, G_{pr} — grafematické priestory.

Obr. 7. Morfografická analýza lineárneho znaku S_L : M — morfémy, G — grafémy, G_{mo} — grafematické (grafické) motívy, G_{pr} — grafematické priestory.

Obr. 8. Morfografická analýza areálového znaku S_P : M — morfémy, G — grafémy, G_{mo} — grafematické [grafické] motívy, G_{pr} — grafematické priestory.

Obr. 9. Znak vystupujúce v znakovom systéme konkrétnej mapy ako významovo nedeliteľné [$S = M = G$].

Obr. 10. Všeobecná morfologická schéma kartografických znakov: S — kartografický znak, syntagma [kartosyntagma], M — morféma, G — graféma, G_{mo} — grafický motív, G_{pr} — grafematický priestor; plné šípky znamenajú morfologický rozklad a prerušované šípky znamenajú morfologický sklad.

Obr. 11. Príklad použitia princípu afixácie: S_1 — trávnatý porast, S_2 — trávnatý porast využívaný ako pasienok, S_3 — trávnatý porast využívaný na seno.

Obr. 12. Schéma afixov podľa polohy voči grafickému invariátu znaku.

Obr. 13. Ilustrácia niekoľkých afixov, rozlišovaných podľa tvaru, počtosti a ďalších kritérií.

Obr. 14. Ilustrácia morfografickej operácie konsociácie: a — paritná konsociácia, b — subordinačná konsociácia.

ОСНОВЫ МОРФОГРАФИИ КАРТОГРАФИЧЕСКИХ ЗНАКОВ

Развитие знакового способа обозначения в картографии к настоящему времени достигло такой стадии, что в замкнутых знаковых системах (на отдельных картах, на их сериях, комплектах) существуют или образуются самые разнообразные виды связей и отношений между графическими элементами и элементами значений картографических знаков. В статье, поэтому, коротко рассматриваются взаимоотношения между формой (графическим обликом), значением (мысленным содержанием) и положением (локализацией) знака, являющимися основной картографической триадой. Доказывается, что не только на тематических, но и на топографических картах, объекты и явления не обозначаются картографическими знаками непосредственно, а косвенно, опосредствованно через значения. Значения, одновременно, играют важную знакообразовательную (морфографическую) роль. На примере знакового обозначения серии значений объекта „мост“ демонстрируется взаимосвязь его 10 значений с соответствующим числом графических обликов знака „мост“ (рис. 2), применяемых на топографических картах. Общим знаменателем всех этих знаков мостов является один мысленный графический инвариант (рис. 3), что и отвечает действительности, так как во всех значениях мостов имеет место один общий эквивалент значения — „мост“. На рис. 4 показываются три смысловые и, одновременно, также графические составные (морфемы) одного из знаков моста. В результате анализа конкретного фигурального, линейного и площадного знака на рис. 6, 7 и 8 иллюстрируется существование также минимальных графических элементов знака — графем, состоящих из графического мотива и графематического пространства. В силу этого картографический знак является знакосложением, синтагмой.

После обобщения этих морфологических признаков можно сделать заключение, что картографические знаки образуются по единой основной морфологической схеме (рис. 10), представляющей собой принцип их графическо-смыслового разложения и сложения.

Способы, графические приемы, при помощи которых можно складывать и видоизменять графическо-смысловые элементы в процессе знакообразования — это морфографические операции (нами их выделено пока 14):

Афиксация — это операция, позволяющая создавать картографические знаки при помощи дополнительных графических элементов — афиксов. Шесть афиксов, в зависимости от их локализации по отношению к основной морфеме, выделил в 1976 г. уже проф. Л. Ратайский, но, как показано на рис. 12, их существует гораздо больше. Кроме того существуют афиксы различаемые по форме, численности и по другим критериям.

Конюгация — это операция соединения и даже объединения графических элементов при помощи либерации (свободного, нерегулярного соединения), контурации (соединения путем оконтурывания), композиции посредством конфигурации (упорядочения в определенную форму, фигуру), версификации (составления в строку, ряд), колумелляции (составления в колонку), курсификации (составления в определенном направлении), дуплексации (удваивания), триплексации (утраивания), ординации (составления в регулярную структуру, сеть), альтернации (чередования) и текстурации (составления в определенный узор, текстуру). Далее сюда относится операция консоциации (объединения) — как равнозначного, так и подчиненного. Эту операцию выделил в 1976 г. также Л. Ратайский, но он ее назвал композицией.

В статье без более подробного освещения приводятся и сопровождаются примерами остальные операции: ротации (поворота, изменения ориентации), конвертации спекулярной (зеркального превращения), конвертации позитив-негатив, растривования (изменения интенсивности), мутации цвета (тона, оттенка), мутации контура

(димензией, узором), претексации (окаймления), сублинеаризации (подчеркивания), магнификации (увеличения), дистрибуции (подразделения), пенетрации (накладывания) и комплементации (заполнения).

Обзор морфографических операций не считается законченным, предполагается его дополнение по мере углубления наших знаний в области картографического знакообразования.

В заключении статьи отмечается, что познавательные исследования в картографии определяются двумя взаимосвязанными направлениями картографического познания. Одно направление — это такое познание объективной реальности (природы, общества), которое обуславливается картографической формой высказывания. Второе направление — это углубление наших знаний о средствах и приемах самобытного картографического способа выражения как системы. Пока что встречаются два мнения насчет организации этой системы. Согласно одного эта система считается формализованным (картографическим) языком, согласно второго она рассматривается как картографический символизм (как семиотическая система). Представления о морфологии картографических знаков, приведенные в этой статье, не противоречат ни одному из этих мнений.

Рис. 1. Отношение реального объекта „мост“ и его обозначения знаком на карте. Прямое отношение объекта к знаку только кажущееся.

Рис. 2. Знаки разных мостов на топографических картах: 1 — мост деревянный, 2 — мост каменный (бетонный), 3 — мост металлический (железнодорожный), 4 — мост на понтонах, 5 — мост подвесной (канатный), 6 — мост на лесах, 7 — мост каменный со ступеньками, 8 — мост каменный с пролетами, 9 — мост двухъярусный с железной дорогой над шоссе, 10 — мост двухъярусный с шоссе над железной дорогой.

Рис. 3. Графический инвариант знака мост (мысленный принцип знака).

Рис. 4. Сложение трех смысловых и графических элементов в знаке S „мост двухъярусный с железной дорогой над шоссе“: M_1 — мост металлический (железнодорожный), M_2 — ... двухъярусный, M_3 — ... с железной дорогой над шоссе; M_1, M_2, M_3 — морфемы, S — знак, синтагма.

Рис. 5. Пример сложения знака железной дороги: S_1 — железная дорога однопутная, S_2 — железная дорога двухпутная, $M_{1,1}$ и $M_{2,1}$ — железная дорога, $M_{1,2}$ — ... однопутная, $M_{2,2}$ — ... двухпутная.

Рис. 6. Морфографический анализ фигурального знака S_F : M — морфемы, G — графемы, G_{mo} — графический мотив, G_{pr} — графематическое пространство.

Рис. 7. Морфографический анализ линейного знака S_L . (Обозначения те же, что и на рис. 6).

Рис. 8. Морфографический анализ площадного знака S_P . (Обозначения те же, что и на рис. 6).

Рис. 9. Если значение знаков в замкнутой системе конкретной карты не подразделяется, тогда $S = M = G$.

Рис. 10. Общая морфологическая схема картографических знаков: S — картографический знак, синтагма (картосинтагма), M — морфема, G — графема, G_{mo} — графический мотив, G_{pr} — графематическое пространство; полные стрелки означают морфологический анализ, прерывистые стрелки означают морфологический синтез.

Рис. 11. Пример применения принципа операции афиксации: S_1 — луг, S_2 — луг используемый под выпас скотом, S_3 — луг используемый для сбора сена.

Рис. 12. Схема афиксов в зависимости от их локализации по отношению к графическому инварианту знака.

Рис. 13. Иллюстрация нескольких афиксов, различаемых по форме, численности и по другим критериям.

Рис. 14. Иллюстрация морфографической операции консоциации: a — равнозначная консоциация, b — подчиненная консоциация.