ANALOG NEGATIVES:

divided development

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February 2015

Divided development

This is an old technique, as it is said to be invented by Heinrich Stöckler, a staff member of Leitz Wetzlar since 1929, and director of the "Leica School", who wrote two articles on the subject in "Leica News and Technique" in 1938 and 1939. Ansel Adams also used this technique, with an adapted version of Kodak's D-23 developer.
As for me, I got interested after the reading of the article "Divided Development" written by Steve Anchell (author of the "Darkroom Cookbook") in the "Camera & Darkroom" issue of December 1993. He wrote this article after a contact with William E. Davis, the author of a small self-published monography, "Simple Pleasures" (I can't resist including a couple of its prints in this text). Since then, I tested the "D2D" formula of W.E.Davis, and adopted it for almost all my negatives processing.

"Snow on steps - Arkansas, 1985" © William E. Davis -- dev: D2D

Developers: their components and how they work

The development's main object is to reduce the silver halide crystals that were exposed to light (the latent image) into metallic silver. Unfortunately, there is no chemical substance able to get a complete development done on its own. Most developers are made up by four components.
The "developing agent" has to be helped by an "accelerator", the role of which is to maintain the pH of the developer at a high and constant value, by neutralization of the bromide ions released during the development. The best known developers are metol (also known as: genol, elon, or rhodol), hydroquinone and phenidone.
The most common accelerators are sodium or potassium carbonate, sodium metaborate (also known as Balanced Alkali used in Kodak's Kodalk) and borax (sodium tetraborate).
The third component is the "preservative" slowing down the rate of oxidation which would quickly exhaust the developer, even when not in use. The best known preservative is sodium sulfite.
Finally, the developers generally rely on a "restrainer", such as potassium bromide or benzotriazole, to prevent the non-exposed silver halides to be reduced by strong developers and to avoid the formation of excessive chemical fog, causing a uniform greyish stain. In too important quantities, the bromide risks to reduce the effective sensitivity of the emulsion as well as the amount of useful density in the shadow areas of the negative.

The principle

Divided development often is called "two-bath development". It would be more accurate to speak about a "processing with a two-bath developer"; as the processing also includes the other well-known traditionnal baths – stop, fix, and wash.

The first bath contains the developing agent, the preservative and possibly the restrainer (when strong developers are used), but no accelerator. When the emulsion is immersed in this first bath, the shadows are rapidly developed. This development will be incomplete, as the developers' power is too weak to affect the least exposed halides. Since very few silver halides are going to be processed in these areas, some active developer will remain in the gelatin at this stage.
On the other hand, the development of the most exposed areas will require the reduction of a much larger amount of salts, resulting in the buildup of soluble bromide, which will gradually restrain the action of the developer, until its total exhaustion.

The second bath only contains the accelerator (alkali): by immersing the emulsion (without intermediate rinsing) in this bath, the still active developer remaining in the shadows areas gets a boost, and the reduction of silver salts will continue there until full development.

Divided development therefore has a significant compensating effect, allowing for detailed shadows and avoiding blocked highlights.

Two-bath developers are also commercially available : Emofin (Tetenal) and Diafine for example.

The benefits

"Corrugated tin - Arkansas, 1989" © William E. Davis -- rév: D2D

First, of course, the compensating effect mentioned above, very useful for low-light/high contrast scenes (concert photography) or otherwise brightly lit scenes with very strong shadows, which can often be found under a bright summer sun for example.

But this compensating action also has interesting side effects:

- *a uniform and stable development*
- *the possibility of controlling the contrast of the negative by choosing the nature and concentration of the 2nd bath*
- *As it is a surface developer, acutance is deemed to be good*
- *Careful selection of the components allows to maintain or improve the sensitivity of the emulsion, making it possible to process all together films with different nominal sensitivities*
- *Temperature has little or no effect on the contrast and density of the negative*

Moreover, these developers often appear to be substantially cheaper than the traditional products, as most of the expensive components are all in the first bath, which will keep indefinetely as long as the bath is not getting contaminated or oxidized. The second bath contains only quite cheap components, and keeps indefinitely as long as it is not used; after use it can be replenished, or even better, simply discarded.

Processing procedure

For the formulas below, it is often recommended not to presoak the film. As for me, I do when the film has a heavy colored anti-halation layer that would dissolve in the first solution (developer A). In all cases, avoid rinsing the film between the two developing solutions (which we will call A and B further in this text).
After passing through A and B, one can rinse the film with water or place it directly into the fixer.
It is recommended to avoid excessive agitation in the developer: gently invert the tank a few times every 30 seconds in A, then use a gentle but continuous agitation in B, for example (as for me, I process my 5"x7" negatives with continuous rotation on a powered roller base without any issue).
The temperature is not critical; it is recommended to keep all solutions are as much as possible at roughly the same temperature, between 20-27°C. Development time does not vary with t°.

The formulae

1 - Kodak DK-20 (super-fine-grain divided developer)

A	B
Eau 52°C ..... 750ml Metol ..... 5,0 gr Sodium sulfite anh. ..... 80 gr Sodium bisulfite ..... 20 gr Potassium thiocyanate ..... 1,0 gr Potassium bromide ..... 0,5 gr Cold water, to make ..... 1 liter	Sodium metaborate ..... 20 gr Water, to make ..... 1 liter *Replenisher: water 750ml, metol 7,5gr, sulfite 100gr, bisulfite 20gr, thiocyanate 5gr, water to make 1 liter*

To use: Solution A is used undiluted. Add 20ml of replenisher for each film developed after the first, then pour off any excess over the original volume (1 liter in this case).
Solution B is diluted 10 times (50ml to make 500ml of working solution) and discarded after use.
Development times:
Films up to 80 ISO: 6½ min. in A, 3½ min in B
100 -- 320 ISO: 10 min in A, 3½ min in B
320+ ISO: 15 min in A, 3½ min in B
Note: this developer can cause dichroic fog on some modern emulsions. Avoid excessive aeration (deep tanks for instance, where film is repeatedly removed from the solution and drained throughout the agitation procedure).

2 - Stöckler divided fine-grain developer

A	B
Water 49°C ..... 750ml Metol ..... 5,0 gr Sodium sulfite anh. ..... 80 gr Cold water, to make ..... 1 liter	Borax ..... 10 gr Water, to make ..... 1 litre

Development time:
Films up to 80 ISO: 3 min. in A, 3 min in B
100 -- 320 ISO: 4 min in A, 3 min in B
320+ ISO: 6 min in A, 3 min in B

3- Divided D-23 (fine grain, high acutance and full tonal scale)

Method 1 - single-cycle

A	B
Water 52°C ..... 750ml Metol ..... 7,5 gr Sodium sulfite anh. ..... 80 gr Sodium bisulfite ..... 20 gr Cold water, to make ..... 1 liter	Borax, granular ..... 18 gr or Sodium metaborate ..... 7,5 gr or Sodium carbonate anh. ..... 4,5 gr water, to make ..... 1 litre

Borax produces the finest grain with the least contrast; carbonate coarse grain and the highest contrast, but also the highest speed. Metaborate produces medium grain with low contrast.

Development time: 3 to 6 minutes in A and 3 minutes in B
Increasing the time in A causes more density, in B the effect will be hardly noticeable.
The fog level might be contained at its minimum, if desired, by adding 10 ml of a 10% potassium bromide solution in A.

Method 2 - multi-cycle This method will produce a more completely developed negative, with added compensating effect.
- 30 to 60 seconds in A
- immerse gently the film in a 1% sodium metaborate solution, leave it for 1-3minutes, no agitation
- 30 seconds in a very weak stop bath (¼ the normal strength)
- complete water rinse
This cycle may be repeated up to 5 times, being careful to invert film spools after each cycle when processing 35mm or medium format films. (Use open tanks, in full darkness).

4- Divided D-76 (higher acutance than with normal D-76)

A	B
Water 52°C ..... 750ml Metol ..... 1,75 gr Sodium sulfite anh. ..... 37 gr Sodium bisulfite ..... 9 gr Hydroquinone ..... 6 gr potassium bromide ..... 0,8 gr Cold water, to make ..... 1 liter	Water 32°C ..... 750ml Sodium sulfite anh. ..... 46 gr Borax, granular ..... 30 gr Cold water, to make ..... 1 liter

Development time: 3 minutes in A, 3 minutes in B
Increasing the time in A leads to higher contrast
Solution A lasts indefinitely, solution B is to be discarded after 20 films

"Window with torn plastic - Arkansas, 1989" © William E. Davis -- rév: D2D

5- D2D - William E. Davis

This is my formula of preference; I've slightly altered some quantities in function of my first experiences.

D2D (William E Davis)		
Solution A1	Water (ml) - 43°C	750
	Sodium sulfite anh. (gr)	70,3
	Hydroquinone. (gr)	15,85
	Water, to make (ml)	1000
Solution A2	Water (ml) - 43°C	750
	Sodium sulfite anh. (gr)	7,8
	Metol (gr)	7,8
	Sodium sulfite anh. (gr)	62,3
	Water, to make (ml)	1000
Solution A	A1 + A2 : mix together after each chemical is completely dissolved	
Solution B	Water (ml) - 43°C	875
	Borax (gr)	39,1
	Sodium carbonate (gr)	31,2
	or: Potassium carbonate (gr)	*39*
	Potassium bromide (gr)	3,91
	Water, to make (ml)	1000
Solution C (replenisher)	Water (ml) - 43°C	880
	Borax (gr)	37,5
	Sodium carbonate (gr)	22,5
	Potassium bromide (gr)	3,75
	Water, to make (ml)	1000
When preparing B/C, do not exceed the 40°C temperature: risc of later cristallisation		
Development	4 min in A	*constant agitation 30 sec, then 5 sec each 30 sec*
	8 min in B	*constant agitation 30 sec, then 5 sec each 30 sec*
	Stop bath 20 sec	
	Water rinse and normal fix	

Please note:

– Do dissolve the various components strictly in the order given.

– For most two-bath developers, the recommended time in B is from 2 to 6 minutes; density will continue to build for up to 8 minutes with this formula, allowing for maximum shadow detail without excessive blocking of the highlights.

– When too much of A is carried over into B, the negatives become grainier. At that point, B has to be replenished by discarding half of the B solution and refilling to the original level with replenishing solution C. Of course, the safest is to mix each time new batches of B.

– As for A, when the level becomes too low, simply bring the working solution back to its original volume with some solution from a fresh batch.

– If you want softer negatives, use less carbonate in B; if you wish them harder, use more; 30 gr is a good average. You might have several B solutions, each of them with a different concentration, and use them in function of the brightness range in the recorded scenes, and the desired contrast.

– With time, both A & B solutions will oxidise, get brown, muddy and form a precipitate: although this shouldn't have any incidence if both solutions are stirred up before using them, I prefer mixing new batches at that point. Even so , the developer remains quite economical.

– People use to say that those old-fashioned two-bath formulae worked better with the old types of film, rich in silver and with thicker crystals than the modern flat "T" ones (Tmax, etc...). As for me, I'm using Foma, Adox et Kodak Tri-X films – 35mm, medium format and 5"x7" – and this developer is working perfectly for me.

I process my 5"x7" sheet films in a Jobo Expert 3006 tank on a second-hand motorised Durst Comot roller base. As my sheet films have a heavily coloured anti-halation layer wish would dissolve in the first bath and pollute it, I always presoak them for 2-3 minutes, with one water change.

– I happen to process six 35mm films (or 3 medium format) at a time, which might be of various sensitivities, in self-made open tanks (PVC pipes Ø 10cm et 27cm high).

An alternative: water-bath development

This method is different, but still somehow similar to divided development: here the film is first immersed in a normal developer and thereafter in a water-bath were it is left without any agitation; the developer absorbed in the gelatin continues its work and is rapidly exhausted in the most exposed areas, while continuing its action in the areas only struck by tiny amounts of light. After the water-bath, the film is returned to the developer , and the cycle is repeated as many times as necessary to achieve the desired contrast and density.

Differences with divided development:

Agitation: With divided development, agitation takes place in both A and B, while the film gently placed in the water-bath is left there without any motion

Cycles: There is only one A-B cycle in divided development (with the exception of the multi-cycle D-23 alternative, which can be considered an intermediate alternative) while the film is going back and forth several times between the developer and the water-bath until the desired contrast and density is reached (this method is often used with "development by inspection").

Developer: the water-bath method makes often use of concentrated developers, and this might lead to quite different results, as far as grain is concerned for instance.

Film sensitivity: water-bath methods usually result in a substantial loss of film speed: the film has to be rated well under its nominal sensitivity.

Film: this technique is less effective than divided development for modern emulsions; it's better to use it with fast, thick-emulsion films such as tri-X and HP5. Good old D-23 is quite well suited to tame extreme contrast with this technique:

D-23	
Water - 52°C	*750 ml*
Metol	*7,5 gr*
Sodium sulfite, anhydrous	*100 gr*
Cold water, enough to make	*1 liter*

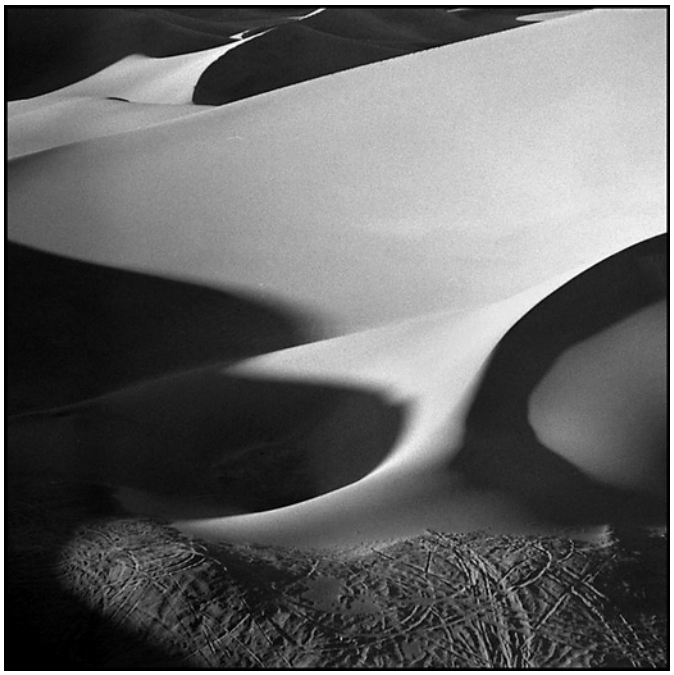
(It is advised to dissolve a pinch of sulfite before the metol, to prevent oxidation of the latter)

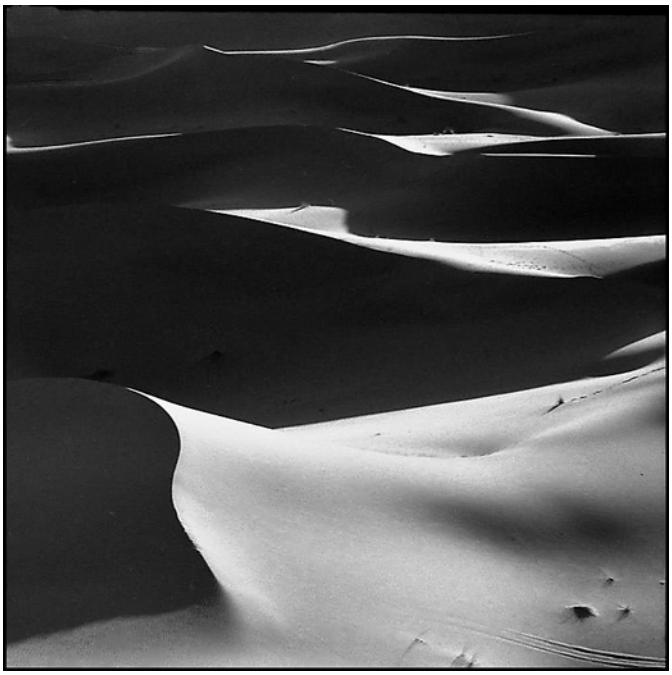
To use:

- 1 minute with constant agitation in developer, then directly 4 minutes in water, without motion
- Repeat this cycle 2 additional times (3 in total)
- After the last water-bath, immerse directly into the fixer

Please note: reduce the film speed at least by one stop to allow enough exposure and good shadow detail.

Portfolio – *Hereunder, some pictures I took in Morocco during January 2013. Tri-X 120 exposed at 320 ISO and processed in D2D developer.*





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